SCIENCE

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THE HARVARD ASTROPHYSICAL CONFERENCE.

THE first Astrophysical Conference, held on the memorable occasion of the dedication of the Yerkes Observatory, was so marked a success and started a movement so important to American astrophysical science that it was to be expected it would result in the perpetuation of such conferences. Both from the graceful tribute brought on that occasion from Harvard, the oldest observatory devoted to astrophysical research, to the newest seeking similar work, and from the fact that Professor E. C. Pickering's fearless application of modern methods of research to far-reaching astronomical problems had made the Harvard Observatory a center of interest to many astronomers, was it eminently proper that the second Conference, and that first proposing a permanent organization of American astronomers, should be held at the Harvard College Observatory.

Quite apart from the scientific papers read and discussed, the Observatory entertaining the Conference in itself constituted a special contribution. In no other observatory could the methods by which modern astronomy is breaking with traditional types of work be more completely and systematically exhibited. Professor E. C. Pickering's vast organization of work, as concretely represented in the photographic and other results accessible to the members of the Conference, was unquestionably the greatest and most inspiring contribution made to the Conference. There were the organized photometric determinations represented not only in Professor Pickering's own work with the meridian photometer, but in the work of Mr. Wendell in accurate

photometric measurements of variable stars, and in the other general photometry systematically carried on by a number of observers. In the photographic enterprises there was the charting of the stars of the entire heavens once every year by means of the eight-inch Bache and Draper photographic doublets and smaller instruments, and the photographic study of the Milky Way on different scales by exposure of four or five hours with the two and one-half inch, eight inch and twenty-four inch Bruce telescopes.

Photographic spectroscopy was represented by a general spectroscopic *Durchmusterung* carried out by an eight-inch telescope provided with an objective prism. For details of the spectra of the brighter stars there were present photographic spectra given by the eleven-inch photographic telescope of the Harvard Observatory and the thirteen-inch at Arequipa, taken with from one to four objective prisms. And for the spectra of very faint objects the twenty-four-inch Bruce, armed with its objective prisms, presented minute details. Among the list of notable discoveries due to these organized methods of research of Professor Pickering there were shown the spectra of the invisible binaries, the spectra of numerous bright line variable stars, the results of study on stars having peculiar spectra, and in the wonderful photographs of clusters, of definition probably surpassing any yet made, were disclosed those hundreds of variable stars in which Professors Pickering and Bailey have just reason to express a proud delight.

Whether the members of the Conference were instructed in shrewd management of stellar photography by Mr. King, or listened to the detailed explanation of the methods of examining photographic spectra by Mrs. Fleming or Miss Maury, with the vast library of plates at their command, or followed Professor Bailey in his most interesting charting of the periods of hundreds of variables in the star clusters, or discussed with Professor Searle the methods by which he is bringing to completion the *Gesellschaft* zone, or reviewed with Professor W. H. Pickering problems in direct telescopic observations, or with Mr. Wendell they followed the highly accurate measurements of stellar magnitude at the equatorial, or whether with any one of the other observers they undertook to follow the work, not omitting the special work with the meridian photometer in which Professor Pickering himself so actively participates, one could not help feeling the presence of a genius for organization and for the determinate solution of vast scientific problems which alike instructed and inspired. It would, therefore, be but just to record the enthusiastic appreciation of the Conference for the contribution which the Director of the Observatory of Harvard College incidentally presented.

Upon organization of the Conference Professor Pickering briefly welcomed the Conference to the hospitality and inspection of the Observatory. The list of papers and their discussion was then immediately begun.

The Conference was presided over alternately by Professor J. R. Eastman, of the United States Naval Observatory, and Professor George E. Hale, Director of the Yerkes Observatory, and the meetings were not only held during the allotted time, August 18th, 19th and 20th, but were carried over to a series of adjourned meetings held during the course of the subsequent week.

Professor Arthur Searle presented his experience on 'Personal Equation in Transit Observations.' He showed that in two observers' work there was a difference in (1) the term $\triangle T + m$, the ordinary personal equation; (2) the collimation micrometrically determined and computed from transits; (3) the apparent position of the

instrument, the axis being more inclined to the plane of the equator for one observer than for another; (4) the apparent rate of clock during the evening, due probably to increasing fatigue; (5) that due to magnitude of stars. Professor Searle pointed out a collimation effect on transits due to bad focus of eyepiece, the lines being displaced by reflected light in illumination. This was shown optically and by a series of transits by two observers, Professor Searle and his assistant, Mr. J. A. Dunne, using different foci of eyepiece.

In the discussion Professor W. H. Pickering suggested that the doubling of wires noticed in the transit instrument under false focusing was analagous to the doubling of the lines of Mars, and that the latter phenomenon was probably due to false focus, and hence doubling of the image in the human eye. Professor Comstock stated that there is a law of variation of personal equation with the declination, but that there is also a variation due to physical condition. When the observer is tired, observations are made more quickly. Professor Eastman said that he had found that malarial fever brought down the personal equation as much as half a second earlier and that there was also a diurnal variation in the personal equation. Mr. Hayford stated that the experience of the United States Coast Survey indicated that personal equation was not appreciably affected by using different forms of signal keys.

Professor George C. Comstock presented 'Some Investigations Relating to Zenith Telescope Latitudes.' In the course of a determination of the constant of aberration it was found that two causes of error entered. In the first place, it was noted that any local temperature changes of the atmosphere unsymmetrical with respect to the instrument had a very serious influence on the apparent variation of the latitude. In the second place, general variation in the atmospheric refraction was no t eliminated The atmospheric layers are not normal to the vertical, and the barometric and thermometric gradients vary irregularly. The zenith telescope gave a constant of aberration varying from 20″.38 to 20″.64, with a range of 0″.26, while even the carefully determined values of Preston, 20″.43, and Gill, 20″.58, gave a range of 0″.15. At least a partial explanation of these variations may be found in the local conditions surrounding the various observatories. Comparing the values derived at New York, 20″.46, with that of Naples, 20″.53, the difference is found to be such as may be accounted for by the diurnal temperature changes accompanying the changing land and sea breezes of the respective places. The large value, 20″.58, obtained at the Cape of Good Hope by Gill is capable of similar explanation, and no case has been found that violates this hypothesis. The result is that the local conditions of every place affect the determination of the aberration constant, and in such investigations it becomes advisable to abandon the zenith telescope and all other instruments which depend upon the vertical as a reference line.

Professor Doolittle stated that he had called attention to the outstanding variations in latitude determinations and believed the cause to be a variation in the refraction. The deviation is a good many times as great as the probable error of the observations. The limit of accuracy of the zenith telescope method has been reached.

Doctor Harold Jacoby presented a paper on 'Photographic Researches near the Pole of the Heavens.' The object of the research is to furnish new values of the fundamental constants of stellar astronomy. The plan consists in making exposures for short trails around the pole, like those first made at the Harvard College Observatory. The records on the plates being made apart from either clock or graduated circle fur-

nish an independent method. The particular negatives used were made at Helsingfors by Professor Anders Donner, and the northerly latitude reduces distortion occasioned by refraction to a minimum. Formulæ suitable for the complete reduction of ordinary polar plates star photographs as well as for the special plates described have been deduced and an application made to measures on one plate of six images of each of ten stars, with encouraging results. A discussion was undertaken, assuming first that the instrument remained fixed during the exposure, and second that it was in motion. Making the reductions according to the latter hypothesis the results are in accord with the best north polar distance determinations of Auwers. The line of motion was vertical, by sagging. All the images on two Helsingfors plates, made six months apart, will be measured and the results treated for a general test of the possibilities of the method. The work already accomplished will soon be published in full detail.

Professor Pickering said that aberration and nutation could be thus best determined, and that the 15-inch Draper telescope has for several years been photographing the pole every clear night with automatic exposure, the plate in some cases hanging vertical so as to eliminate one equation of condition. Professor Paul held that lateral and vertical refraction might enter as disturbing factors. Professor Comstook, while agreeing with Professor Paul as to the possibility of refraction variations, held it to be highly desirable that Doctor Jacoby should prosecute his researches. Doctor Jacoby remarked that a new method like this should be received with scepticism and that the test of this plan would be by thorough work extending perhaps over one generation.

Mrs. M. Fleming's paper on the 'Stars of the 5th Type in the Magellanic Clouds' was presented by Professor E. C. Pickering.

Stars having spectra consisting mainly of bright lines belong to Type V. In 1891 the number of these stars known was thirty-three. Three of these were discovered by Wolff and Rayet, one by Respighi, six by Copeland, three by Pickering and twenty from the Draper Memorial Photographs of the Harvard College Observatory. In May, 1897, the number known was sixty-seven. All of these stars lie closely along the central line of the Milky Way, and, although the sky had been equally well covered with spectrum plates from pole to pole, a careful examination of the plates failed to show any of these stars outside of this region.

On May 26, 1897, an examination of two photographs taken at Arequipa with the Bruce telescope showed a group of six of these objects in the Large Magellanic Cloud. Two later plates add fifteen more, and these with three other stars in the Milky Way, and one in the Small Magellanic Cloud, make the total number of these stars, so far known, ninety-two. Thirteen of these were found visually; all the others have been found by Mrs. Fleming from Draper Memorial photographs. The great advantages of photography in the study of stellar spectra is thus again demonstrated.

The presence of so many stars of the Fifth Type in the Magellanic Cloud establishes another connection between this object and the Milky Way.

Professor Solon I. Bailey presented a paper on 'Variable Stars in Clusters.' A systematic examination of twenty of the most interesting, dense, globular clusters has been made. In these clusters 18,600 stars were compared, of which 501 were found to be variable. In only a few of these clusters does the percentage of variables amount to more than one per cent., and in many cases it is less. A few clusters, however, give remarkable results. The most striking is Messier 3, where 132 stars out of a total of 900 are variable, or one in seven. Other

clusters remarkable for the number of variables are Messier 5, Omega Centauri and Messier 15. These four clusters together have 393 variables. At the present time the periods and light curves of more than one hundred have been determined. These periods are generally less than 24 hours, and are characterized by an abrupt increase in light and a slower decrease. These results have all been obtained by photography. They would have been impossible with instruments of the same size by visual methods. The photographs were made with a 13″ telescope. The faintest variables are quite invisible in the same telescope, and it is doubtful if they can be well studied visually in a telescope of less than 30″ or 40″ aperture. The shortest period of these variables is $6^h\ 11^m$, which makes it the shortest period known.

Professor Bailey's remarkable work was rendered extremely interesting by the exhibition of some of the original photographs and of the numerous charts of the change in brightness of these variables which he had been able to prepare. Professor E. E. Barnard stated that he was surprised that this great discovery had attracted so little attention. He knew the photographic plate could be depended on. The great Yerkes telescope very readily verified the periods. He had verified three of Professor Bailey's periods, but was afraid the visual was inferior to the photographic method. Father Hagen stated that the stars were on the limit of visibility in the 12-inch telescope, and there seemed to be no charts of these clusters. Professor Pickering stated that photographic charts of the clusters would be furnished by the Harvard College Observatory.

Mr. Albert S. Flint, in a contribution on 'Meridian Observations for Stellar Parallax,' presented a summary of the results of the observations for stellar parallax, made at the Washburn Observatory, on a list of nearly one hundred stars. The method employed is that of differences of meridian transits. The value of the method is confirmed by the good agreement with other accurate determinations of stellar parallax and by the absence of any plainly indicated systematic errors. The first comparison gave an average difference of only 0″.03 on the fifty stars elsewhere observed. The probable error of the definitive parallax for any one star varies from 0″.030 to 0″.040, except for great zenith distances. The values depend upon from forty to sixty observations extended through from four to six epochs. A new series of similar observations has been begun, which will include second-magnitude stars and binaries. The new Repsold transit micrometer will be employed, with which the observer maintains bisection with a movable thread, while the chronograph signals are made automatically by the revolving micrometer head.

Professor Comstock said that while the average accuracy of the method is not as great as with the heliometer or by photography more observations can be made and gross error eliminated. The method is useful for a general parallax survey.

Professor Charles Lane Poor, in a paper on 'The Direct Grating Spectroscope and its Applications to Stellar Photography,' stated that already in 1891 and 1892 he had experimented with the direct vision grating in photographing star spectra, and had taken the problem up afresh in the fall of 1897, using both a 2-inch grating and a specially ruled grating of 6.5 inches aperture and 39 inches radius of curvature. Properly mounted on a guiding telescope good photographs of stars to fourth magnitude resulted. Many of these were exhibited by Dr. Poor. Aside from the advantage of securing normal spectra, the method permits the determination of the relative wave-length shift by photograph-

ing two stars on same plate. Dr. George E. Hale stated that a machine, intended to rule gratings 9 inches by 15 inches, was now being built at the Yerkes Observatory. The great difficulties attending ruling of surfaces of sharp curvature were described by Dr. Poor.

In discussing the methods of producing normal spectra of stars, Mr. Edward S. King stated that at the Harvard College Observatory two methods of transforming the prismatic into the normal spectrum had been tried with success. In the first, photographs were taken of the original plate through a slit with the plates moving at differential rates. In the second method the plates are inclined to the axis of the lens, so as to make the scale exact for three points of it while maintaining good focus. The first method is applicable for producing any unequal change of scale. The second, though of an approximate character, is the better working method. Mr. King showed admirable photographic comparisons of star spectra with Rowland's map.

Professor E. C. Pickering added that the method just described was thoroughly general and that all scales were thus reproducable. He believed that the Orion lines could be well investigated by a grating, as suggested by Dr. Poor.

Professor G. W. Hough discussed 'The Effect of Atmospheric Disturbance on Telescopic Definition.' The local atmospheric disturbances should be differentiated from the general atmospheric conditions. As the object-glass of the largest telescope is infinitely small compared to the size of the atmospheric waves the disturbance will vary directly with the magnifying power. When a disturbance is just in front of the instrument there is displacement and distortion as well. Capping the object-glass usually produces no improvement.

Professor W. H. Pickering said the local conditions at Arequipa are satisfactory. Caps make little difference with large telescope, but with 6-inch telescope, or less, caps are valuable. Double stars are not the best test of seeing, but rather detail work on planets. Professor Hale said small telescopes are not as good in fair seeing as big ones for any work. There are many false statements on this point. The two faults of seeing are jumping and blurs. At Flagstaff there is a lively jumping. The highest power used at Yerkes is from 2,500 to 3,000.

Miss Agnes M. Clerke's paper 'On the Spectra on Certain Nebulæ,' read in the author's absence by Professor Snyder, called attention to the demand for a special study of the spectra of white nebulæ, by reason of the nature of their structure, their mode of distribution in the heavens, and the quality of their light differentiating them from the gaseous nebulæ. Miss Clerke proposed 30 Doradûs, whose spectrum Professor E. C. Pickering had described as 'partly stellar and partly gaseous;' Messier 1, of which Pierce and Winlock, and later Campbell, had made interesting observations, and N. G. C. 6299 as examples of this anomalous class. Professor E. C. Pickering, exhibited several recent photographs of spectra of the nebulæ indicated by Miss Clerke.

Mr. J. F. Hayford, in speaking of a 'Proposed Publication of the Coast and Geodetic Survey,' said that the Coast and Geodetic Survey proposes to publish in the form of a catalogue of north polar distances the computed data which it now has in its possession. The catalogue will comprise stars which have been observed for latitude in the survey. The number of stars, 6th magnitude and brighter, comprised in the catalogue will be about 3,500. The degree of accuracy pertaining to each polar distance and proper motion will be indicated by attached probable errors. The systematic corrections and weights assigned in

the computations to each catalogue are substantially those assigned by Professor Lewis Boss in his report on similar work for the Northwest Boundary Survey in the seventies.

Professor Pickering presented a paper by Mrs. M. Fleming on the 'Classification of the Spectra of Variable Stars of Long Period.' In the classification of the spectra of stars in the Draper Catalogue the letter M was assigned to stars having spectra of the third type. Later these stars were subdivided into four groups, Ma, Mb, Mc and Md, of which α Orionis, α Herculis, $-2°3653$, and o Ceti were given as examples. In the last of these stars the hydrogen lines are bright, and this spectrum has been shown to be characteristic of variable stars of long period; indeed, by this peculiarity in the spectrum about a hundred new variable stars have been found. A further examination of these spectra shows that they can be further subdivided into eleven groups. A classification made from an examination of the continuous spectrum, the comparative brightness of the hydrogen lines being also carefully estimated, always assuming the brightness of Hγ as 10, the first class, of which R Lyncis is the typical star, showed a spectrum resembling α Tauri, and having Hβ and Hγ strongly bright, and nearly equal, while Hδ was barely visible. The last group, of which R Leonis is a typical star, shows a continuous spectrum like $-2°3653$ with Hβ invisible, Hγ barely visible and Hδ strongly marked.

The original photographs were exhibited and examined by the Conference.

Professor G. W. Myers presented 'A Study of the Light Variation of U Pegasi.' The hypotheses assumed were: (1) The light curve given by Pickering in Harvard College Observatory Circular No. 23 represents the true nature of the light change of this star near enough to determine provisional orbital elements, and (2) The light change is capable of explanation on the satellite theory. After the discussion showed the desirability of introducing a flattening, the further assumption was made: (3) The two components are deformed by tidal influence into similar ellipsoids of revolution.

Equations were then derived connecting the light curve with the 'elements' defining the system whereby the latter might be derived from the former, and *vice versa*. From these equations the following results were obtained: The light curve of U Pegasi, given in circular No. 23, is satisfactorily represented by the satellite theory with a circular orbit, whose radius differs but slightly from the sum of the major axes of the components, and whose inclination is very nearly 90 degrees. The smaller component has a brightness of about 0.77, and a radius of 0.78 of the larger, while a slight flattening of the disks probably exists. Accuracy of present observations does not warrant a least square adjustment of the outstanding residuals. There is some reason to believe in the existence in this system of the apioidal form of Poincaré.

Professor E. C. Pickering said it was astonishing how slight were the differences between observed and theoretical values of the brightness, and this agreement was confirmatory both of the observations and the theory. Mr. H. M. Parkhurst could not accept the period assumed, and questioned the accuracy of determinations of minima differing by but .15 of a magnitude. Professor M. B. Snyder held that the relation of Professor Myers' present work to that of Doctor See on the evolution of binaries was quite remarkable, and, seeing that Doctor See's prediction of variation of eccentricity was just what Doctor Myers had required as an hypothesis in treating the similar variable β Lyræ, the results were anything but discouraging to all the hypotheses involved in their interesting work.

Professor George E. Hale, exhibiting a set of remarkable photographs, presented a

review of work on 'The Spectra of Stars of Secchi's Fourth Type.' The spectra of 22 stars of this type have been photographed with the 40-inch Yerkes telescope, in most cases with a dispersion of one prism. For the stars Schjellerup 132 and 152, which are the brightest specimens of this type, the three-prism spectrograph was also employed. The photographs all show a large number of lines hitherto unrecorded. Most of these are dark, but there seem to be a certain number of bright lines. These show best with high dispersion, and are not weakened in intensity by widening the slit. The brighter ones have been observed visually, in Schjellerup 132 and 152, using a dispersion of three prisms. At Dr. Hale's request the spectrum of Schjellerup 152 was observed visually with the 36-inch telescope of the Lick Observatory by Professors Keeler and Campbell, who concluded that bright lines were almost certainly present. Further tests of these lines are being made at the Yerkes Observatory. The wave-lengths of two of the brightest of these lines agree very closely with the wave-lengths of two of the brightest lines in the spectra of the Wolf-Rayet stars, as measured by Professor Campbell. It is still too early to conclude, however, that any connection exists between the stars of the fourth type and those of the Wolf-Rayet class. In this connection it should be remarked that the fourth-type stars, as plotted by Mr. J. A. Parkhurst at the Yerkes Observatory, show a much stronger tendency to cluster in and near the Milky Way than any other stars except those of the Wolf-Rayet type. It has been found possible to arrange the spectra of eleven fourth-type stars in a series, having at one end the star DM 59° 2810 and at the other Schjellerup 155b. The investigation, which is being made with the assistance of M. F. Ellerman and Doctor Schlesinger, will be continued during the coming year.

Professor E. E. Barnard exhibited a series of photographs illustrating the work that had been done with the 6-inch aperture lens. These consisted of photographs of various portions of the Milky Way, showing its cloud forms and intricate structure. Many singular peculiarities were shown, such as the great rifts where the Milky Way appears to be rent asunder as if it were breaking up. The impression is that certain portions of the Milky Way consisted of sheets of stars of comparatively little depth, and it is in such regions that the process of disintegration seems to be going on. In some of the great clouds of stars are shown very distinct black holes, in the densest portions, as though tunnels perforated through the cloud masses and permitted one to look into the blackness of space beyond. Another striking feature is the presence of vacant lanes or black channels among the stars of the Milky Way. In these no stars seem to exist. Still another feature is the strange geometrical arrangement of the stars in curves in certain regions, as if some force were at work in this structural arrangement, baffling for the present direct explanation. One of the most extraordinary features is the presence of vast regions of faint diffused nebulosity, mixing up with the stars of the Milky Way. This nebulosity is better dealt with by the photographic plate, because it is too faint to affect the human eye. It is suggested that when this remarkable feature comes to be thoroughly studied, it will doubtless lead to a better understanding of the physical condition of the Milky Way and of its origin.

The photographs of comets, especially of Brooks' of 1893, show most remarkable and rapid changes in the form and structure of the tail. It seemed to suggest that the tail may have encountered some resistance in its flight through space. Comets are perhaps the only objects that would be able to

point out such streams of resistance. It is possible that the tail of this comet swept over a meteor stream or some other less resisting medium in space on the 20th, 21st and 22d of October, 1893. Portions of the tail seemed to have been torn off and to be drifting away from the comet as independent masses, and, if our ideas of comets are correct, these might themselves become swarms of meteors.

The series of photographs shown indicated the valuable results attained and the wide field of study opened by this method of research.

Mr. A. Lawrence Rotch gave 'A Brief Account of the Work of the Blue Hill Meteorological Observatory,' in which he described the peculiar instruments used, and adverted to the scientific character of the work carried on. His account was accompanied by photographs of the instruments, and on closing the description he invited the Conference to an inspection of the Observatory, which was cordially accepted and participated in by many of the members. Those who visited the Blue Hill Observatory were greatly impressed with the methods and appliances used in the difficult problems of meteorological research there attempted.

Miss A. C. Maury read a paper on 'The K Lines of β Aurigæ.' She said β Aurigæ is a double star whose components revolve in a period of $3^d\,23^h\,37^m$ approximately, and with a velocity in the line of sight of 150 miles a second. As the distance between their centers, supposing the plane of the orbit to pass through the sun, is only about eight million miles, the stars are, of course, inseparable by the telescope, but their spectra become separated when, in the course of revolution, one star is approaching the earth and the other receding from it. By the Doppler principle, all the lines of the combined spectrum then appear double, those of the star approaching being shifted toward the violet, those of the star receding, toward the red.

Photographs of the double spectrum, two hundred in number, obtained at the Harvard Observatory during the past nine years, show that the K line (of calcium) varies periodically in intensity. It is stronger in one star in the photographs of one year and in the other star in those of the year following, the relative intensity thus alternating for nine years. This variation, though less perceptible, may extend to other lines of the spectrum. It seems probable that the revolving stars, which are nearly or quite alike in mass and constitution, induce in one another reciprocal variability.

A similar variation has been suspected by Professor S. I. Bailey in the components of the Spectroscopic binary μ' Scorpii, as shown in the Photographs obtained in Peru.

Professor Winslow Upton presented the methods of determining 'The Position of the Arequipa Station of the Harvard College Observatory.' The latitude of the Arequipa station was obtained by observations in the prime vertical made with a special instrument designed by the late Professor William A. Rogers. The observations were made by two Besselian methods, the extreme range for individual observations being 7″. The final value for the latitude is $-16°\ 22'\ 28''.0 \pm 0''.19$. The longitude was obtained by telegraphic exchange of time signals between Arequipa and Arica, Chile, the longitude of the latter station having been determined in 1883 by officers in the United States Navy by means of the coast cables. The difficulties of making the exchange directly made it necessary to repeat the signals in passing from the land telegraph line to the cable. The difference of longitude was determined with a probable error of $\pm 0^s.032$, and the resulting longitude is $4^h46^m11^s.71$ west of Greenwich.

Mr. Henry M. Parkhurst, in a paper on

'The Rotation of the Asteroids,' discussed his photometric observations, extending over a number of years, on planets Nos. 40 and 42, and from these observations concludes that no hypothesis of rotation need be introduced to account for any changes in brightness.

Dr. Herman S. Davis presented a paper, read by Professor Upton, on 'The Parallaxes of 61 and 62 Cygni and the Probable Physical Connection of these two Stars.' From a review of the observed photographic results of parallax and the apparent difference in parallax of the two stars, the author concludes that 'these two stars are moving through space independently of each other and separated from each other by an interval represented by two and one-quarter light years;' but does not 'regard this difference of parallax as an entirely indisputable fact.' He, however, insists that the two stars of 61 Cygni should be regarded as too remote from each other to form a binary system until more evidence is adduced to disprove this conclusion.

Professor Comstock said he was of the opinion that the stars were at some distance; considering the difference of parallax 0″.08, Dr. Davis' is not the only hypothesis allowable. A more plausible hypothesis is that one of these stars is accompanied by a dark companion, about which the star revolves so as to counteract the motion of the earth. The *a priori* probability in both hypotheses is perhaps the same. Professor Frisby thought that the parallax determination showed overlapping values not consistent with Dr. Davis' hypothesis. Professor Flint pointed to the large range of variation in the parallax determinations of these two stars and thought Dr. Davis' hypothesis unwarranted.

Professor Charles L. Doolittle reviewed the 'Work of the Flower Observatory.' Double-star observations made by Mr. Eric Doolittle, on a list prepared by Mr. Burnham, have been made with the 18-inch telescope of Mr. Brashear. The difficult pairs observed are a fair test of the performance of the instrument. The theoretical power of separation is 0″.275 and yet in one case a pair separated by 0″.24 has been measured. Comparing the work of the Brashear instrument with similar observations made by Mr. Burnham with the Clark instrument of approximately the same aperture at Evanston, it is found that the Brashear instrument will resolve all pairs shown by the Clark. Fourteen pairs of new doubles have been picked up, and this indicates that an ample harvest is yet to be reaped. Four hundred and fifty pairs have been measured on three different evenings, and the results will soon be published. Professor Hough thought the results had certainly shown the Brashear objective to be a good one.

A paper by Professor Arthur Searle on 'Faint Stellar Bands in the Ecliptic' was read by Mr. William Maxwell Reed. If faint stellar bands exist in the ecliptic the observed shape of the *Gegenschein* would certainly be affected. Such bands Professor Searle has observed. The most prominent of these extends from Aquila through Aquarius and Pisces to the neighborhood of η Tauri. Another falls close to the ecliptic. It commences in Gemini and ends in Coma Berenices. These bands seem to be a part of a network, of faint bands that cover nearly the whole sky. The *Gegenschein* is not always perfectly round.

Professor S. I. Bailey, in discussing this paper, said that in his observation of the *Gegenschein* in Chile and Arequipa he had never been able to see the *Gegenschein* perfectly circular. He suggests that the faint bands might be photographed, and thus their character and brightness better determined. He had, however, not been able to photograph the zodiacal light. Drawings of the bands as made independently both

by Professor Searle and Mr. Reed were exhibited, and, considering the delicacy of the observations, coincided well.

Professor Frank W. Very, in a paper on 'The Probable Range of Temperature on the Moon,' described his experimental work in determining the radiation from diverse substances at ordinary temperatures. Special attention was called to the compensation involved in radiation from subsurface molecules, which narrows the range of radiant emissivity, as exercised by different materials. Hence, the errors committed in classifying radiators in a very few, or, under certain restrictions, even in a single division, are not large. Measurements of lunar radiation have been carefully made at various phases, and the interpretation of these results in terms of absolute measurement is now possible. The method of reduction was indicated, and the final conclusion was that the moon's surface temperature lags behind the possible temperature which might be given by the sun's rays throughout most of the seven days of the lunar morning. A retention of heat by the surface material of the moon is thus shown, but the retention is so small that almost the whole of the heat received while the sun is above the horizon is lost before sundown on the same day, and thus the proper radiation from the surface, which in the case of the earth goes out to an entire circumscribing sphere, emanates virtually from only half the surface of the moon while it is undergoing insulation. The day temperature of the moon consequently becomes extremely high—above that of boiling water, except in the polar regions—while at night the cold approaches that of space.

Professor William H. Pickering presented a paper (not read) on 'Swift's Comet I., 1892.' This comet, discovered March 6th, was first noticed to have a faint tail, by Finley, on March 26th. As discovered at Arequipa, March 29th, the tail was well developed. Forty-four photographs were taken of this comet and used in a recent investigation of its nature. The tail was plainly two-fold in character, the inner tail continuously issuing from the head, and, being at least 20 degrees in length a month after passing perihelion, consisted of two absolutely straight rays inclined at an angle of 10 degrees. The outer tail was formed by successive eruptions from the head, later diminishing in angle. The whole effect was to produce multiple tails like the comet of 1744. The photographs showed the inner tail to be of a different character on alternate days, now appearing continuous near the head and now bifurcated. The explanation is that the comet rotates about a longitudinal axis directed toward the sun, the rotation period determined being 94.4 hours. This period was determined by the use of the photographs made at Arequipa by the writer, and corrected by those of Professors Barnard and Wolf. Bessel observed in Halley's comet, in 1835, 'a vibration from side to side' with a period of 110 hours; this was probably a similar rotation of the comet with an analogous period. The changing appearance of both comets being explicable by the hypothesis of rotation, the next endeavor was to find a physical explanation of the cause of such rotation. The sun furnishes a strong electro-magnetic field. The comet also by the electrical induction of the sun receives electrical charges, and these charges are, by the gases of the tails, radially projected from the head of the comet, and become in effect so many electrical currents. The result of the motion of these radiating currents, *i. e.*, tails, in the magnetic field of the sun is the production of a spinning of the comet about a longitudinal axis. Theory would thus produce the rotation demanded by observation, and the rotation would be independent of the direction of the motion of the comet,

but north of the solar equator the rotational force is in one direction, and south of it in the other.

It is generally impossible to indicate a point in the tail of the comet; the exception occurs on the plates of April 5, 6, 7, 8 and 10, where a bright detailed structure is receding with increasing velocity of from one million to twenty-five million kilometers per day. The velocity of recession is 36 times the acceleration of gravity, and does not agree with any of the velocities required by Bredichin's hypothesis. The spectrum, as given by an objective prism, of the head and tail showed five bands probably due to hydrocarbons. A further test of the theory of axial rotation of comets near the sun would be an observed change of direction or speed of rotation in the solar magnetic field. Another would be the observation of the rotation when the tail is directed approximately toward the observer.

Professor Edward C. Pickering presented to the Conference a letter he had received from Professor H. H. Turner, of the University Observatory, Oxford, England, conveying a provisional statement in reference to measures and comparisons made of plates forwarded him by Professor Pickering. He writes in part: "The optical distortion on the plate is quite small, if existent—up to 3° from the center, and perhaps further. Whatever may be the ultimate definitive result as regards optical distortion, your plates will give (by the allowance for such distortion, which will be quite easy) as good places as we are getting on the plates for the Astrographic Catalogue. The images are perhaps a little larger and more diffused, but are quite easy to measure. This holds for certainly $4° \times 4°$, and probably further. If I am right in believing that fear of optical distortion was the motive for rejecting the photographic doublet the above conclusions show this fear to have been groundless, and the manifest advantages of getting a large field at once prove the doublet to be the right instrument, certainly for charting purposes. If you think this brief note will be of any interest at the Conference, please make use of it."

The subject of 'The November Meteors' was discussed, and Professor Pickering referred to the desirability of obtaining observations in various parts of the sky and in various longitudes, as indicated in a circular issued by the Harvard College Observatory. Professor Barnard recommended the short-focus lantern lens in the photography of the meteors. Professor Pickering referred to the fact that at present there seemed to be no available method of determining the direction of motion of the meteor from its trail on the plate. Professor W. H. Pickering suggested the desirability of pointing the camera in the neighborhood of the radiant. Third-magnitude meteors could thus be photographed. Professor Barnard indicated that meteors seemed to become visible some distance from the radiant. Professor Hale referred to Doctor Elkin's experience as indicating the photographic difficulties. Professor Searle stated that since small meteors appeared near the radiant, and large ones away from the radiant, it was probable that the body of the meteor concealed the light when near the radiant. Professor Eastman said the experience of most observers is that the largest meteors appear at some distance from the radiant. It seems quite likely that Professor Searle's hypothesis gives the true explanation. Professor Barnard thought that, since meteors must penetrate some distance before attaining high illumination, perspective would show them at some distance from the radiant. Professor Eastman suggested the photographing of persisting meteor trails. Professor Barnard had seen the smoke for ten minutes, and in one case thirty minutes, after the

flight of the meteor. The trails broke up into knots. Invariably the trails moved eastward among the stars. Mr. E. S. King referred to the accidental photograph of the spectrum of a meteor in the prismatic camera. Professor Hale regarded the photographic spectra of meteors as obtained at the Harvard College Observatory as of the highest value.

Professor Edward C. Pickering, as chairman of the committee appointed at the previous conference to secure the republication of the *Durchmusterung* charts, reported a list of some forty odd subscribers in America, and stated that the charts would shortly be published. Father Hagen stated that Doctor Küstner has written that numerous errors were being corrected, the largest list of these being furnished by Professor Pickering.

General plans for observing the total eclipse of the sun on May 28, 1900, were briefly discussed, and it was agreed by the Conference that unity in the methods of observation could be best attained by appointing a committee to consider the whole question and report on plans at the next conference. The Conference appointed as the committee, Pickering, Comstock and Barnard.

The matter of better organization of the United States Naval Observatory was brought before the Conference, and on motion a committee was appointed to solicit an expression of opinion on this subject from members of the Conference and other astronomers, the committee also to cooperate with similar committees from other scientific bodies in considering the general question of the reorganization of the scientific departments of the government. The Conference, by ballot, selected Professors Pickering, Hale and Comstock as the committee.

One of the most important questions brought before the Conference was the creation of a permanent astronomical and astrophysical society. It was formally resolved that it was desirable to form such a society, and a committee, consisting of Professors Hale, Comstock, Pickering, Newcomb and Morley, was appointed to report to the Conference on the subject. Subsequently the same committee reported a general plan, and was continued as a council further to consider the organization of the society and make arrangements for the time and place of the next meeting of the Conference.

A number of interesting instruments, apart from those developed and used in the complex work of the Harvard Observatory, were exhibited, and among them a zenith sector made by Rittenhouse, and a transit instrument and quadrant, all used by Andrew Ellicott in the last century. The exhibit of chronographs represented: The first Bond chronograph; the last chronograph made by the inventor, Richard F. Bond, and still capable of determining time to within a few thousandths of a second; a new form of electrically controlled chronograph of Professor A. G. Webster; and a Hough's Printing Chronograph, made by Edmund Kandler, of Chicago, for the Philadelphia Observatory. The latter instrument prints the minute, second and hundredth of the second. W. C. Bond & Sons, of Boston, also exhibited a break-circuit chromometer, and Professor Pickering an ingenious instrument for determining periods of periodic variations.

The following ninety-two persons were present at the Conference: C. G. Abbot, W. H. Attwill, S. I. Bailey, E. E. Barnard, N. E. Bennett, H. H. Brackett, Henry S. Carhart, F. L. Chase, H. Helm Clayton, W. H. Collins, H. R. Colson, G. C. Comstock, Charles R. Cross, A. E. Dolbear, Miss H. R. Donaghe, Charles L. Doolittle, H. W. Dubois, John A. Dunne, J. R. Eastman, Mrs. I. W. Eddy, W. S. Eichel-

berger, W. L. Elkin, S. P. Ferguson, R. A. Fessenden, Edward P. Fleming. Mrs. M. Fleming, Albert S. Flint, Edgar Frisby, R. H. Frost, Miss Caroline E. Furness, Miss E. F. Gill, H. M. Goodwin, Miss Ida Griffiths, J. G. Hagen, George E. Hale, J. F. Hayford, Miss Lillian Hodgdon, G. W. Hough, Harold Jacoby, E. S. King, Laurence La Forge, Miss E. F. Leland, F. H. Loud, C. Lundin, Alex. Macfarlane, Miss A. C. Maury, C. H. McLeod, D. C. Miller, Edward W. Morley, G. W. Myers, S. Newcomb, Henry M. Parkhurst, H. M. Paul, B. O. Peirce, Edward C. Pickering, Mrs. Edward C. Pickering, William H. Pickering, Charles Lane Poor, Miss Mary Proctor, Alden W. Quimby, F. G. Radelfinger, Wm. Maxwell Reed, Charles H. Rockwell, Jonathan T. Rorer, A. Lawrence Rotch, W. C. Sabine, F. E. Seagrave, Arthur Searle, Aaron N. Skinner, Frederick Slocum, M. B. Snyder, Charles E. St. John, John Stein, Miss M. C. Stevens, A. E. Sweetland, Winslow Upton, J. M. Van Vleck, Frank W. Very, Robert DeC. Ward, Charles F. Warner, W. R. Warner, A. G. Webster, Oliver C. Wendell, Miss Sarah F. Whiting, Frank P. Whitman, Miss Mary W. Whitney, Miss A. Winlock, Miss L. Winlock, Miss E. G. Wolffe, Miss I. E. Woods, R. S. Woodward, Paul S. Yendell.

At the close of the Conference Professor Comstock presented a motion recording the thanks of the Conference to Professor and Mrs. Pickering and the members of the Observatory staff for the generous hospitality of the Harvard College Observatory; to the President and Fellows of Harvard College for courtesies and hospitality extended; and to Professor Charles R. Cross for hospitality accorded by the Massachusetts Institute of Technology. With the unanimous adoption of this motion the Conference adjourned.

The undersigned begs to acknowledge his indebtedness to the members of the Conference for generous aid given in the preparation of the foregoing report.

M. B. Snyder.

GEOLOGY AND GEOGRAPHY AT THE AMERICAN ASSOCIATION MEETING.

I.

By the invitation of Section E (Geology and Geography) of the American Association, meetings of the Geological Society of America and of the National Geographic Society were held with this Section, the former in three sessions on Tuesday forenoon, afternoon and evening, August 23d, and the latter on Thursday afternoon, the 25th. These sessions, and those of Section E, were held in the lecture room of the Boston Society of Natural History, excepting the final session, on Friday forenoon, which was held in the geological lecture room of the Museum of Comparative Zoology, in Cambridge.

The address by the Vice-President of Section E, Professor Herman L. Fairchild, of Rochester, N. Y., on 'Glacial Geology in America,' was presented on Monday afternoon. It reviewed the history of the development of this branch of geology in the United States and Canada, concluding with the assertion that the origin of the North American drift through the action of a continental ice-sheet is now, after fifty years of exploration and discussion, as fully proved as any of the principles of geology. It is published in the September *American Geologist* and in the *Scientific American Supplement* for September 3d, 10th and 17th.

In the opening session of Section E, with the Geological Society, on Tuesday forenoon, short memorial addresses on the life and work of the late Professor James Hall were given by Professors Emerson, Fairchild and Niles, and by Dr. Horace C. Hovey, noting Hall's earnestness in boyhood and youth to acquire knowledge of geology and allied sciences, walking twenty

miles from his home in Hingham, Mass., to attend lectures by Benjamin Silliman before the Boston Society of Natural History, his distinguished services of more than sixty years on the Geological Survey of New York, and his recent illness and death, August 7th.

The papers presented before the Geological Society of America, with brief notes of their scope, mostly as stated in the Society's preliminary announcement, were as follows:

1. *Some Features of the Drift on Staten Island, N. Y.* By ARTHUR HOLLICK, Columbia University, New York City. The terminal moraine crosses Staten Island from Fort Wadsworth at the Narrows to Tottenville, opposite Perth Amboy, N. J. Its front rests partly on the serpentine ridge and partly on the plain region to the south. In the former locality it consists of true morainal material of the northern drift. In the latter it comprises a ridge or core of Cretaceous and Tertiary clays, sands and gravels, shoved forward and upward from their original position on the island, and on top of these disturbed beds are the morainal till and gravel. At two localities there are well defined indications of extra-morainic drift, south of the terminal moraine. The direction of glacial movement is indicated by the striæ on rock outcrops to be about S. 17° E.

The most abundantly represented boulders are those derived from the Triassic of New Jersey, although nearly all the outcrops between Staten Island and the Adirondacks have contributed. A list of about 120 Palæozoic fossils obtained from the transported boulders was appended to this paper, with another list of about 35 Cretaceous and Tertiary species, mostly fossil plants, derived from the disturbed Staten Island strata.

2. *Loess Deposits of Montana.* By PROFESSOR N. S. SHALER, Cambridge, Mass. (Read by title.)

3. *Glacial Waters in the Finger Lake Region of New York.* By PROFESSOR H. L. FAIRCHILD, Rochester, N. Y. This paper noted the stages of glacial retreat and consequent changes of drainage, by which the glacial Lake Newberry, outflowing southward to the Susquehanna, was succeeded by Lake Warren, about 100 feet lower; and this, when the ice was further melted back, by Lake Iroquois. For the most definite stage between Lakes Warren and Iroquois, represented by a large beach at Geneva, N. Y., and by an old channel of eastward outflow south of Syracuse, the name Lake Dana is proposed.

4. *The Stratification of Glaciers.* By PROFESSOR HARRY F. REID, Baltimore, Md. Lantern views of the glaciers of Switzerland and Alaska were displayed, attention being directed to the author's observations of the persistency of the original stratification occasioned by the snowfall of successive years on the névé. This structure was distinguished from the transverse blue banding, analogous to cleavage, which is occasioned by pressure of the moving ice, being especially developed in constricted or very steep parts of the glaciers.

5. *Evidences of Epeirogenic Movements Causing and Terminating the Ice Age.* By WARREN UPHAM, St. Paul, Minn. The vertical amount of the preglacial elevation of North America, during late Tertiary and early Quaternary time, is shown to have ranged from 3,000 to 5,000 feet, according to the soundings of fjords and submerged valleys on our Atlantic, Pacific and Arctic coasts, the deepest of these valleys, exceeding 5,200 feet, near Monterey, California, having been described by Davidson a year ago. Similarly it is also known that a general uplift of western Europe and western Africa took place near the same time, of varying amount, from a minimum of probably about 1,500 feet in the British Isles to maxima of about 4,000 feet in Scandinavia, nearly 9,000 feet in the country adjoining the

southeast part of the Bay of Biscay, and more than 6,000 feet at the mouth of the Congo. These great uplifts are thought to have given the cold and snowy climate under which the ice-sheets were amassed. But the lands were afterwards depressed, in the closing, or Champlain, epoch of the Glacial period, to levels mostly somewhat below their present heights, whereby a temperate climate, with warm and even hot summers, was restored on the borders of the ice-sheets, melting them gradually from the periphery inward. Steep frontal gradients and vigorous glacial currents were thus produced, heaping much of the drift in prominent recessional moraines.

6. *Clayey Bands of the Glacial Delta of the Cuyahoga River at Cleveland, O., compared with those in the Implement-bearing Deposits of the Glacial Delta at Trenton, N. J.* By Professor G. Frederick Wright, Oberlin, O. A year ago Professors Wright, Hollick, Mercer and Libbey made excavations at Trenton in the field where Mr. Ernest Volk has been working under the direction of Professor Putnam. As a result of their work, they found several implements from three to four feet below the surface, and beneath certain red clayey bands which they supposed to be a part of the original delta deposited at Trenton during the close of the Glacial period. In the meetings of the American and British Associations, however, at Detroit and Toronto last year, vigorous efforts were made by others to prove that these clayey bands do not belong to the original water deposition, but may have been wind-blown surfaces or lines of oxidation in the sand. During the past year Professor Wright has made numerous observations upon excavations in a similar delta of Glacial age at Cleveland, where he finds a succession of reddish clayey bands in the sand precisely similar to those at Trenton; and at Cleveland they merge into cross-bedded sand and gravel strata on the same level, showing unequivocally that the whole is a water deposit, and that it has not been disturbed since the original deposition. This strongly confirms the inferences drawn a year ago concerning the age and undisturbed character of the deposits at Trenton from which Mr. Volk has derived so many implements for Professor Putnam, indicating that men were present, making, using and losing those implements at the time of departure of the ice-sheet.

7. *The Middle Coal Measures of the Western Interior Coal Field.* By H. Foster Bain and A. T. Leonard, Des Moines, Iowa. These coal measures are marked by non-persistence of strata. The upper measures are more regular. Between the two is a series partaking of the characteristics of each. This series includes the Raccoon River beds, the Appanoose formation and equivalents in Iowa, the Henrietta in Missouri, and the Oswego and Pawnee limestones of Kansas. No fitting general term for the whole has yet been proposed. The old term, middle coal measures, included the beds here referred to and the higher beds now quite generally known as the Pleasanton shales.

8. *The Principal Missourian Section.* By Charles R. Keyes, Des Moines, Iowa. The previous classifications of the Carboniferous formations of the region west of the Mississippi River were briefly outlined. The results of the recent work along the Missouri River were summarized and the inferences to be drawn were given. The Missourian series, as one of the four principal subdivisions of the Carboniferous of the continental interior, was described. Eleven well defined formations or stages are shown to have a wide distribution, the formations in five States being correlated.

9. *Tourmaline and Tourmaline Schists from Belcher Hill, Jefferson County, Colorado.* By Horace B. Patton, Golden, Colo. Black tourmaline, often in fine large crystals,

occurs very abundantly in pegmatite veins that cut the crystalline schists of the foothills of Jefferson county, west of Denver, Colorado. On the Belcher Hill road, near Golden, the tourmaline occurs: (*a*) in separate crystals; (*b*) in black masses (schorl) in quartz veins; (*c*) the same in pegmatite veins; and (*d*) in finely disseminated needles replacing biotite and even feldspar and quartz in biotite schists and gneisses at contact with veins of pegmatite and quartz. The beautiful banding and cross-banding produced by this replacement is unusual. The paper was illustrated by specimens and photographs.

10. *Magmatic Differentiation in the Rocks of the Copper-bearing Series.* By ALFRED C. LANE, Houghton, Mich. In many of the effusive sheets a difference may be noted between the top and the bottom. At the top the feldspar is oligoclase, at the bottom labradorite. At the top olivine is more conspicuous, at the bottom augite. The oligoclase and olivine were evidently formed before the lava from which the sheet was formed came to rest, at least in part. The augite and labradorite were probably formed later. It is possible that the early formed oligoclase rose to the top, and that the sodiferous magma there formed had not such corrosive action on the olivine as the calcareous magma left below, the latter causing the olivine to be changed to augite. Comparing different flows, we find the same kind of relations that exist between the top and bottom of the same flow. This suggests that similar differentiation went on before eruption.

11. *The Volume Relations of Original and Secondary Minerals in Rocks.* By PROFESSOR CHARLES R. VAN HISE, Madison, Wis. This paper discusses the volume relations of secondary minerals as compared with original minerals, and considers this volume change in reference to the depth at which the alteration occurs.

12. *Note on a Method of Stream Capture.* By ALFRED C. LANE, Houghton, Mich. When the divide between two streams is porous, and the valley of one much deeper than that of the other, springs may arise on the side of this deeper valley, which drain the water from the higher valley and thus diminish the erosive capacity of the stream therein, until the higher valley has a stream only in times of rain and is soon eaten into by lateral tributaries of the deeper stream. Various illustrations of this action were given, and it was noted that the streams draining the ice-front during the Glacial period were especially liable to capture because they occupied channels heavily filled with porous gravel and sand.

13. *The Development of the Ohio River.* By PROFESSOR WILLIAM G. TIGHT, Granville, Ohio. A brief review of the literature shows that it has been generally accepted that the Ohio River is a very ancient stream, but recently the work of several geologists in New York and Pennsylvania indicate the Pleistocene origin of the Ohio above New Martinsville. In papers already published by the author the existence of a very ancient erosion basin extending in general from east to west through the central part of Ohio and Indiana is established by the restoration of many tributary drainage lines and by deep wells. Further evidence is presented in this paper to show that the Ohio in its present location has been established through the appropriation of sections of numerous northwardly and northwestwardly flowing streams by the cutting of the ancient cols and the broadening and deepening of the valleys. The explanation for these changes is found in the position and action of the ice-sheet in the various sections, thus determining the age of this part of the Ohio valley to be Glacial or Postglacial.

The theory is proposed that the development of the Ohio River almost entirely be-

yond the greatest extent of the ice-sheet, and of the Missouri River almost entirely within the limits of the ice, was due to the different angles which these streams made with the ice-front, and to their different gradients. In the Ohio basin the water was forced over distant cols; but in the Missouri basin it was drained southeastward along the ice-front, thus wearing back the ice at the time of final recession before the establishment of the channel by erosion.

14. *Classification of Coastal Forms.* By F. P. Gulliver, Southboro, Mass. A scheme is proposed in this paper for the classification of the various forms of the coast according to their stage of development. Two markedly different classes of initial forms are recognized, those following elevation of the land and those following depression. Each class is seen to have characteristic forms at various stages of its development, and the writer urges others to think of all the forms on the coast or along the shore as in a certain stage of their life-history. This will further suggest the form from which any given example has come and toward which it tends to develop.

15. *Dissection of the Ural Mountains.* By F. P. Gulliver. The Urals are seen to be pretty thoroughly planed, so that the summits of the many ridges rise to nearly the same elevation, except a few commanding peaks which are found to consist of quartzite or other rock more resistant than the surrounding beds. The summit-level plane descends gradually to the west until it merges into the upland levels of the great plain of Russia, while on the east in several places there is a rather steep fall-off to the Siberian plain, though in other places the plane of the summits merges into that of the great Tertiary deposits of northwestern Asia. The stages of dissection in various parts of the Ural Mountains, and the grade-planes of different streams, are compared, the result of such comparison being that there seem to be three epicycles or divisions of the present cycle of erosion.

16. *Note on Monadnock.* By F. P. Gulliver. The relation of Monadnock to the New England upland was considered, and the valleys in the vicinity of this mountain were described. The elevations of two former stream grades have recently been determined in this region.

17. *Spacing of Rivers with Reference to the Hypothesis of Baseleveling.* By Professor N. S. Shaler, Cambridge, Mass. (Read by title.)

18. *The Continental Divide in Nicaragua.* By C. Willard Hayes, Washington, D. C. The comparatively short streams, with steep gradients, descending to the Pacific, have in numerous instances increased their drainage basins by capture of the headwaters of streams flowing eastward to Lake Nicaragua and the Caribbean Sea. In this way the water divide on the surveyed line for the Nicaragua Canal has been removed a considerable distance eastward, being now at a much lower altitude than the original mountainous watershed.

The following papers were presented in the session of the National Geographic Society :*

1. *The Venezuela-British-Guiana Boundary Dispute.* By Dr. Marcus Baker, Washington, D. C.

2. *Considerations Governing Recent Movements of Population.* By John Hyde, Washington, D. C.

3. *Some new Lines of Work in Government Forestry.* By Gifford Pinchot, Washington, D. C.

4. *The Development of the United States.* By W J McGee, Washington, D. C.

5. *Atlantic Estuarine Tides.* By M. S. W. Jefferson.

6. *The Forestry Conditions of Washington State.* By Henry Gannett, Washington, D. C.

* See the account by W J M in the issue of Science for September 16th.

7. *The Five Civilized Tribes and the Topographic Survey of Indian Territory.* By CHARLES H. FITCH, Washington, D. C.

8. *Bitter Root Forest Reserve.* By RICHARD U. GOODE, Washington, D. C.

The papers of Section E of the Association were as follows:

1. *Outline Map of the Geology of Southern New England.* By PROFESSOR B. K. EMERSON, Amherst, Mass. This paper, with maps, gave a summary of the areal geology of Massachusetts, Rhode Island, Connecticut, and parts of New Hampshire, Vermont and New York.

2. *Basin in Glacial Lake Deltas.* By PROFESSOR H. L. FAIRCHILD, Rochester, N. Y. During the glacial recession the impounded high waters of the Canandaigua valley, in central New York, at one time escaped across the eastern border of the basin into the Flint creek valley, which was also occupied by a glacial lake at a lower level. The river thus formed cut a channel in drift and rock, and deposited the débris, as a delta, at its mouth in the lower lake. The delta now forms a conspicuous plateau of gravel 125 feet above the adjacent village of Potter. In this plateau is an irregular depression which reaches to the very base of the delta deposit, and occupies, perhaps, a fourth of the area of the plateau. The only satisfactory explanation of its origin is that an isolated block of ice was left there by the receding ice-front, and that the delta material was piled around it, the subsequent melting of the ice block producing the cavity. Elsewhere shallow basins occurring in deltas are in many cases attributable to deficient filling by capricious currents and wave action; but such bowls cannot be confounded with the Potter kettle-hole, which was illustrated by a map and photographs.

3. *An Exhibition of the Rare Gems and Minerals of Mt. Mica.* By DR. A. C. HAMLIN, of Bangor, Maine. (Read by title.)

4. *The Hudson River Lobe of the Laurentide Ice-sheet.* By PROFESSOR C. H. HITCHCOCK, Hanover, N. H. The glacial drift and striæ of Quebec, New England and New York prove the existence of a glacial lobe following the Champlain-Hudson valley. The movement was to the southeast over the summits of the White and Green Mountains and to the southwest over the Adirondacks, but due south along the medial valley. Last October the author climbed Orford Mountain, which rises northwest of Lake Memphremagog to an altitude of about 5,000 feet above the sea, and found it glaciated from bottom to top, wholly in a southeasterly course. All over the mountain were found boulders of Laurentian gneiss, which (according to their determination by Professor Frank D. Adams, of Montreal) must have come from the north side of the St. Lawrence River. It had before been shown that the highest mountains of New Hampshire and Vermont were glaciated from the northwest, but doubt had been lately expressed about Orford Mountain. These observations prove that the Laurentide ice-sheet overrode all these mountains, flowing from the region north of Montreal and Quebec southward and southeastward to the sea border.

5. *The Age of the Amboy Clay Series as indicated by its Flora.* By ARTHUR HOLLICK, Columbia University, New York City. Investigations in the paleobotany of the Amboy Clay series and the equivalents on Staten Island, Long Island, Block Island and Martha's Vineyard, conducted during the past twenty years by the late Dr. J. S. Newberry, Dr. Lester F. Ward, Mr. David White, the writer and others, have shown that the formation which includes them is very closely related to the Atane and Patoot beds of Greenland, the Dakota group of the West, the Albirupean series of the South and the Cenomanian of Europe, so that there was no hesitation in declaring them

all to be Middle Cretaceous in age. This conclusion seemed to be quite generally accepted and was apparently not questioned until about two years ago, when an announcement was made, with some show of authority, that the series is probably Jurassic in age. In regard to the correlation of the several formations mentioned there can be no question. The large amount of paleobotanical material available for comparison has given opportunity for the identification of so many species common to them all that this conclusion is not only justifiable, but inevitable, and the only question is whether the correlation also demonstrates that the several formations are Middle Cretaceous in age. If any one of them is, then they all are; if any one is not, then the others are not.

In paleobotany, as in paleozoology, the broad general facts are recognized that the biological sequence is coincident with the geologic sequence, and that the farther back in geologic time the simpler and lower in the scale of life were the organisms. Hence, if we divide our fossil flora into the three great classes of cryptophytes, gymnosperms and angiosperms, the sequence of their appearance and periods of maximum development would be in the same order. The percentages of these classes in any floras should, therefore, be a fair indication of the relative ages of the floras. A typical Jurassic flora, such as that of Siberia, contains, roughly, the following percentages: cryptophytes, 22; gymnosperms, 74; and angiosperms, 4. The Older Potomac flora, which is regarded as Lower Cretaceous, contains the same classes in the percentages of 39, 39 and 22; the Newer Potomac, regarded as Middle Cretaceous, 8, 13 and 79; the Amboy clays, 6, 13 and 81; the Dakota group, 1, 5 and 94. Similar examples of percentages are also calculated for other floras regarded as Cretaceous in age. The main fact, which is at once seen, is the manner in which the percentages of the gymnosperms and angiosperms are reversed. Few angiosperms, and only those of doubtful character, have been found in any formation recognized as Jurassic, so that when it was ascertained that in the Amboy Clay flora and its equivalents the angiosperms represent from 70 to 90 per cent. of the entire flora there was little hesitation in considering it as well advanced in the Cretaceous period. There would be nothing inconsistent in regarding the lowest of the Older Potomac strata as Jurassic, but even there it would require definite paleontologic evidence, while in regard to the Amboy Clay series it is safe to say that a Jurassic fauna will never be found in connection with its flora.

In face of the direct evidence of the fossil flora, therefore, it would seem a very hazardous undertaking, without ample evidence in rebuttal, to draw the line of separation between the Jurassic and Cretaceous so that in the West the base of the Cretaceous would be represented by the Dakota group and in the East by the clay marls of of the Matawan formation. (The paper was illustrated by tables of percentages and charts.)

6. *Some Feldspars in Serpentine, in Southeastern Pennsylvania.* By Professor T. C. Hopkins, State College, Pa. Feldspar occurs in this district as dikes or veinlike masses in serpentine, sometimes attaining a thickness of 20 to 25 feet. The most extensive area is in Chester county, extending also into Lancaster county; but there is another area in central Chester county, near the corundum mines. The feldspar is snow-white to pink in color, and seems to be wholly orthoclase. Some of the dikes have been exploited to a depth of 60 feet.

7. *The Region of the Causses, in Southern France.* By Rev. Horace C. Hovey, Newburyport, Mass. Lofty tablelands in the Departments of Lot and Lozére, along the

western declivity of the Cevennes Mountains, are known as the Region of the Causses. The term 'causse' is derived from the Latin word calx, meaning limestone. Some of the finest roads in Europe run along the plateaus, and occasionally descend into the valleys. But the author's exploration, here noted, led by E. A. Martel, of Paris, left all beaten paths at the village of St. Enimie, launched in canoes, and followed the winding gorges of the Tarn for 46 miles, and then, by mules or in carriages, explored the gorges of the Jonté and Durbais. The Causses vary in height from 1,000 to 5,000 feet above the sea, and these gorges are cut through them somewhat as the Grand Canyon of the Colorado cuts through the plateaus of Arizona. The cliffs of the river Tarn are often from 1,000 to 2,000 feet high, and occasionally still higher, and are brilliantly colored.

The caverns of the region are as remarkable as any in Europe. There are hundreds of them, and of all sizes. Among the large caverns explored by this party may be mentioned those of the Baumes Chaudes, three in number. From one of them the late Dr. Pruniéres exhumed 300 prehistoric skeletons, and in another are nine vertical pits from 40 to 127 feet deep. Another cave destined to become famous is that of Darjelan, with twenty halls from 65 to 600 feet long, the lowest of them being 420 feet deep. The author's party discovered and explored the Aven Armand, down whose chasm Louis Armand was the first to go. This vertical pit is 240 feet deep, beyond which is another 300 feet deep, the total vertical depth being 600 feet by actual measurement. The descent was made by a series of rope ladders, and was not without its dangers. The stalactitic decoration of these caves is remarkably fine.

The term 'aven' is applied to what we call a 'sinkhole,' except that the avens seem to pass more abruptly into pits or chasms. They pierce the Causses from the drainage level, and are death-traps for animals whose remains were found below in various stages of decomposition and whose bones lie imbedded in the dripstone. The theory is that every aven has a passageway to the rivers of the region. That this is often so is proved by the great springs at the base of the cliffs of the Tarn; but in some cases the subterranean passages trend away from the streams instead of toward them, and often they are dry, showing that the drainage must have been at some remotely ancient period.

Should it be asked why the wonderful Region of the Causses has so long escaped exploration amid a country of high antiquity, the answer is that these lofty plateaus are barren solitudes, except for the chalets of wandering shepherds. The gorges and avens have been objects of dread instead of places attracting visitors. The superstitions of the peasants have also operated to make them shun what a few tourists now delight to explore. Under the stimulus of the Société de Spéléologie, the region is being opened to the public, and it is destined to be resorted to by thousands of tourists when its interesting features become more widely known.

8. *The Washington Limestone in Vermont.* By C. H. RICHARDSON, Hanover, N. H. This name is proposed by the author for the more calcareous member of the Calciferous mica schist of Professor C. H. Hitchcock. It is for the most part a very dark silicious rock, the color of which is due to finely disseminated carbon. This formation, varying from 2,000 to 5,800 feet in thickness, extends from south to north through Vermont; but its most important development, economically, is in the townships of Washington and Topsham, Orange county, where, within the past five years, numerous valuable marble quarries have been opened in it. The chemical compo-

sition of specimens of this marble from a deep test pit at one of the quarries is very remarkable, no less than eighteen elements having been detected in its analysis.

9. *Fluctuations of North American Glaciation shown by Interglacial Soils and Fossiliferous Deposits.* By Warren Upham, St. Paul, Minn. From a comparison of our continental drift deposits with the present retreatal conditions of the piedmont Malaspina glacier in Alaska, it is concluded that the fauna and flora adjacent to the retiring ice-sheet were nearly like those of the same latitudes to-day, and that fluctuations of the ice border to the extent of a few miles, a few score, or a few hundred miles, more acceptably account for our interglacial beds, former surface soils and leached subsoils, than a general departure and renewal of the ice-sheet.

10. *Time of Erosion of the Upper Mississippi, Minnesota and St. Croix Valleys.* By Warren Upham. Until the Ozarkian epoch of great elevation of the northern part of this continent, inaugurating the Quaternary era, the upper part of the present Mississippi basin, above the vicinity of Dubuque, appears to have been drained northerly, according to recent studies by Hershey (*American Geologist*, Vol. XX., pp. 246–268, October, 1897). After the Cretaceous marine submergence of the State of Minnesota, its chief river system probably flowed through the Red River Valley to Hudson Bay during the Tertiary era, being reversed to take nearly the course of the Minnesota and Mississippi Rivers at the end of that era. The St. Croix River is thought by the author to have obtained its passage through the rock gorge of the Dalles at Taylor's Falls, Minn., so late as the Buchanan Interglacial epoch, preceding the Illinoian and Iowan glacial readvance; and the channel of the Mississippi from Minneapolis to Fort Snelling, eroded during the Postglacial period, has afforded to Professor N. H. Winchell his well-known estimate of that period as between 7,000 and 10,000 years.

11. *Supposed 'Corduroy Road' of Late Glacial Age, at Amboy, Ohio.* By Professor G. Frederick Wright, Oberlin, Ohio. This paper detailed the discovery of a series of logs lying side by side as in a corduroy road, and extending for a distance of 200 feet or more, which were covered by 30 feet of gravel, in which were found the tooth and tusk of a mammoth, the tusk being 10 feet long, 22 inches in circumference at the base, and weighing 155 pounds. The resemblance to a corduroy road was, indeed, very striking, but the appearance of the logs showed that they were driftwood, and had been buried by the accumulation of the gravel that took place along the old shore of Lake Erie, when, during the closing centuries of the Glacial period, the water was held up to a level 150 feet higher than now. The logs and base of the deposit are 140 feet above the lake and about 4 miles back from it, on the banks of Conneaut Creek, in the extreme northeastern corner of Ohio. The gravel was evidently brought down from the higher lands of the south, near the sources of the creek, and was deposited with the mammoth remains in a delta at the edge of this old glacial lake. In connection with this investigation it was ascertained that similar deltas of gravel characterize the margin of the old lake where other streams from the south met it at various places between this point and Cleveland. Altogether, these observations give a very vivid picture of the rapidity with which coniferous forests proceeded to cover northern Ohio as the ice melted back, and of the promptness with which the immense animals of the time reoccupied the territory. Important inferences are also derived, showing that the period of time during which the water remained at the high levels of the old ice-dammed lakes was short.

12. *Changes in the Drainage System in the Vicinity of Lake Ontario during the Glacial Period.* By DR. M. A. VEEDER, Lyons, N. Y. The paper noted sections of wells in buried river channels south of Lake Ontario, from the Niagara River eastward to the Mohawk Valley.

13. *Recent Severe Seismic Movements in Nicaragua.* By JOHN CRAWFORD, Managua, Nicaragua. Description of a series of earthquakes experienced in western Nicaragua from April 29th to May 12th of this year, as reported by the author in the *American Geologist* for July (Vol. XXII., pp. 56–58).

WARREN UPHAM,
Secretary of Section E, 1898.

(*To be Concluded.*)

THE BOTANICAL SOCIETY OF AMERICA.

THE fourth annual meeting was held at Boston, August 19 and 20, 1898, under the presidency of Dr. N. L. Britton.

In the absence of Professor C. R. Barnes, Secretary, Dr. B. L. Robinson was elected Secretary *pro tem.*

The following new members were elected: Robert A. Harper, University of Wisconsin, Madison; Edward A. Burt, Middlebury College, Middlebury, Vt.; Herbert J. Webber, Department of Agriculture, Washington, D. C.; L. H. Pammel, Iowa Agricultural College, Ames; Albert S. Hitchcock, Kansas Agricultural College, Manhattan; Herbert Maule Richards, Harvard University, Cambridge, Mass.; David G. Fairchild, Department of Agriculture, Washington, D. C.; David M. Mottier, University of Indiana, Bloomington.

In the absence of the retiring President, Professor John M. Coulter, his address, entitled 'The Origin of Gymnosperms and the Seed Habit,' was read by Dr. B. M. Davis. It has been published in this JOURNAL.

The following papers were presented:

1. On Sporogenesis in *Arisæma*. By Professor George F. Atkinson.

2. Symbiotic Saprophytism. By Professor D. T. MacDougal.

3. Sporogenesis in *Trillium*. By Professor George F. Atkinson.

4. The Structure and Development of the Centrosphere in *Corallina*. By Dr. B. M. Davis.

5. Relations Between the Forest Flora and Geological Formations in New Jersey. By Dr. Arthur Hollick.

6. Preliminary Notes on the Fertilization of the White Pine. By Miss M. C. Ferguson (by invitation of the Council).

7. Notes on a *Helianthus* from Long Island. By Dr. N. L. Britton.

8. Tetrad-formation in *Tsuga*. By W. A. Murrill. (Presented by Professor Atkinson.)

9. A Fossil Moss from the State of Washington. By Mrs. E. G. Britton and Dr. Arthur Hollick.

The following officers were elected for the ensuing year: President, Professor L. M. Underwood; Vice-President, Dr. B. L. Robinson; Treasurer, Dr. Arthur Hollick; Secretary, Professor Geo. F. Atkinson; Councillors, Professor C. E. Bessey and Dr. W. P. Wilson.

MEETING OF THE AMERICAN FORESTRY ASSOCIATION AT BOSTON.

THE meeting of the American Forestry Association, held in connection with the American Association for the Advancement of Science, was chiefly interesting for the reports of progress of the forestry movement. The sessions were held at Horticultural Hall, on Tuesday, August 23d, to Thursday, August 25th. The social features and excursions of interest, lavishly provided by a local committee and the Massachusetts State Forestry Association, formed a prominent part of the meeting. The opening session was mainly occupied by reports from delegates of various States as to the condition of the forestry movement. Forest Commissioner Rothrock, of Pennsylvania, reported progress in the establishment of State Forest Reserves. Mr. Austin Cary, of Maine, referred to his employment by a paper-pulp manufacturing company to direct the logging of their large forest

property according to forestry principles. Forest Commissioner Fox, of New York, reported on the acquisition of Adirondack lands by the State to the extent of one and a-half million dollars. On Tuesday afternoon the Association, in a body, drove through the Middlesex Fells, and the discussions in the evening, after a dinner at the hotel situated in the forest park, turned naturally on the application of silviculture to such parks. It appeared that the Metropolitan Park Commission had not yet formulated plans as to the management of the woodlands. Dr. Schenck, of Baltimore, and Mr. Olmstead, of the well-known firm of landscape architects, advocated sound measures for the replacing of the worthless coppice growth, which is bound to deteriorate, by a healthy seedling growth.

An important feature of the meeting was the discussion of the aims and objects of the newly established State College of Forestry at Cornell, by its Director, Dr. B. E. Fernow. This address will be printed in full in SCIENCE. In the discussion Professor Lazenby referred to a movement in similar direction which was shaping itself in Ohio. Among the usual resolutions which it is the custom to pass at these meetings the most important was one calling upon the federal government to place its forest reserves under technical non-political management.

The Association adjourned to hold another summer meeting at Omaha, in connection with the Trans-Mississippi and International Exposition.

NOTES ON PHYSICS.

GAY LUSSAC'S LAW AND ATMOSPHERIC NITROGEN.

A VERY curious deviation of atmospheric air from the Laws of Gay Lussac and Boyle has been studied by H. Teudt (Zeit. für Phys. Chem., XXVI., p. 113). When first heated, the expansion above 350° is excessive. The deviation from Gay Lussac's Law being 2 per cent. at 400° and 3 per cent. at 450°. This anomalous expansion is exhibited by atmospheric nitrogen alone, but not by oxygen, carbon dioxide, chemically prepared nitrogen, by air which has been previously heated, nor by air collected after a rain. Teudt suggests, in explanation, the existence of an allotropic form of nitrogen and points out that the close relationship between nitrogen and phosphorus supports this view; the allotropic form of nitrogen being changed to the ordinary form at high temperatures. Holborn and Wien, in connection with their work on the air thermometer, have pointed out that air at the first heating does not conform to Gay Lussac's Law.

LIQUID AMMONIA.

E. C. FRANKLIN (Paper read before Section C at Boston) has made an elaborate study of liquid ammonia, which has been known for some time to approach water in its properties as a solvent. He finds its heat of vaporization to be about 330, while the calculated value is 358 by Trouton's formula, 321 by the formula of Wood, and 330 by the formula of Peabody. He finds the constant of molecular elevation of the boiling point of liquid ammonia to be 3.4, which is lower than for any other known substance. He has measured the electrical conductivity of various substances dissolved in liquid ammonia, and he finds the conductivity to increase with temperature, reach a maximum and then decrease, becoming zero at the critical temperature of liquid ammonia.

H. M. Goodwin (Paper read before Section B at Boston) has determined the dielectric constant of liquid ammonia and finds it larger, indeed, than the dielectric constants of alcohol, ether and the like, but not so nearly equal to that of water as was

expected from its electrolytic dissociating power.

MEASUREMENT OF THE INTENSITY OF SOUND.

INSTRUMENTS for the measurement of sound intensities were described before Section B at Boston by Professor A. G. Webster and by Dr. J. O. Reed. In Professor Webster's instrument the amplitude of vibration of a thin glass diaphragm is measured by the interferometer, the fringes being photographed on a moving plate. In Dr. Reed's instrument the amplitude of vibration of a diaphragm is observed by means of a micrometer microscope focussed upon the tip of a stylus attached to the diaphragm.

Professor Webster outlined a method for calculating the absolute intensity of the sound (amplitude of the periodic force acting upon the diaphragm) from the observed amplitude of vibration. In this outline Professor Webster made use of the equation of motion of a system with one degree of freedom, namely,

$$\frac{d^2x}{dt^2} + \beta \frac{dx}{dt} + \alpha x = Ae^{pt}.$$

Now, this equation is, in fact, applicable to any system vibrating in a given simple mode (*i. e.*, when the period of each particle of the system is the same and its amplitude a one valued function of its position) but it is impossible to determine the coefficient α by static measurements of any kind. The effect of the air which vibrates with the diaphragm can, however, be taken into account so that the coefficient α may be approximately determined, by using as a resonator a long air column. However, the results of some determinations by Professor Webster agree quite well with sound intensities as measured by Rayleigh.

W. S. F.

NOTES ON INORGANIC CHEMISTRY.

THE first number of the *Chemical News* in September is known as the 'Students' Number,' and is devoted to a description of the chemical departments of the British universities and colleges. It is noticeable at once that the facilities for chemical study in Great Britain are very far behind those of Germany, and I think we may fairly say below those of America. Probably a dozen or even more institutions could be found in this country where greater advantages are offered than anywhere in England. Three colleges only have more than one professor in the chemical department, viz.: Victoria University, Yorkshire College, Leeds, with a professor in the dyeing department, and a professor in the leather industries department, in addition to the professor of chemistry; Owens College, Victoria University, Manchester, with a professor of chemistry and a professor of organic chemistry; Glasgow and West of Scotland Technical College, with a professor of chemistry and a professor of technical chemistry. The Royal College of Science and Royal School of Mines has, in addition to a professor of chemistry, an assistant professor, and King's College has a professor of metallurgy. In the number of teaching force also the British colleges would seem to be deficient. The average number of instructors, including all assistants and demonstrators, in the twenty-nine colleges mentioned is less than four, and this average is strongly brought up by Owens College and Yorkshire College, each of which has a corps of ten instructors, and the University College, Liverpool, with seven. The two former would appear to be the only colleges of Great Britain with adequately equipped chemical departments; Oxford and Cambridge hardly seem to be in the race.

THE same number of the *Chemical News* contains, as its single item of current news,

the statement that the War Office authorities have decided to do away with part of the scientific training at the Royal Military College at Woolwich, by closing the chemical laboratory—a curious step backwards for modern times.

In investigating pitchblende to find why the activity of the Becquerel rays is not proportionate to the amount of uranium present, a rule holding in general for compounds of uranium, M. P. Curie and Mme. S. Curie have isolated a new substance which appears to be a new metal. It is, according to the *Comptes Rendus*, thrown down with the bismuth sulfid and partly separated by heating in vacuum to 700° C., the sublimate obtained having 400 times the activity of uranium. The spectrum, however, emits no characteristic lines. The name of *polonium* is suggested for the new substance, from the country where the pitchblende was found. J. L. H.

ZOOLOGICAL NOTES.

In a recently issued excerpt from the Bulletin of the U. S. Fish Commission, Dr. Hugh M. Smith treats of the Florida Commercial Sponges, briefly describing the species taken and discussing the causes of their decrease and the possible remedies for it. The causes of decrease are the usual ones, the taking of small sponges and excessive fishing; the proposed remedies are the enforcement of the laws against taking small sponges and the prohibition of sponging on certain grounds for definite periods. From the very rapid rate of growth assigned to the most valuable species, the sheepswool sponge; it is evident that the restocking of the depleted sponge beds would be a very simple matter if the above remedial measures could be enforced. Dr. Smith tells us that experiments seem to show that the sheepswool may, under favorable conditions, attain a weight of one tenth of a pound in six months and reach a commercial size in a year. He considers that sponge culture promises well for Florida waters, where, for some reason, growth is more rapid than in the Mediterranean. On the other hand, the introduction of Mediterranean sponges is regarded as problematical, and it is a question if the introduced sponges would retain their superiority under the changed environment. The paper is illustrated by numerous half-tone plates of commercial sponges.

F. A. L.

CURRENT NOTES ON ANTHROPOLOGY.

THE ZOQUE LANGUAGE.

An important contribution to American linguistics is the 22d volume of the 'Bibliothéque Linguistique Américaine' (Paris, Maisonneuve), which has just appeared. It is entitled 'Langue Zoque et Langue Mixe,' and is edited by M. Raoul de la Grasserie (1898, pp. 384). Most of it is occupied with the Zoque, of which a grammatical outline is given and a vocabulary of nearly 7,000 words from the MS. of Father Luis Gonzales (1672). This is further compared with the modern Zoque as spoken at present in Chiapas.

The Mixe is represented by the Grammar of Father Quintana (1730), a short vocabulary and some texts.

The work closes with a comparison of the Zoque and Mixe, showing them rather closely related members of the same stock, though with notable differences in words and in morphology, especially that the Mixe prefixes the pronoun in the conjugation, while the Zoque suffixes it.

M. de la Grasserie has edited these materials with great care, and the volume is a valuable addition to linguistic literature.

THE ANTHROPOLOGY OF BRUNSWICK.

On the occasion of the meeting this year of the German Anthropological Society at Brunswick, a little volume has been issued

on the anthropology of that duchy ('Beiträge zur Anthropologie Braunschweigs,' pp. 163, 1898, Braunschweig, Vieweg). It contains nine essays by local writers, beginning with the remains of palæolithic man in the 'diluvial' strata by Dr. W. Blasius. The relics seem to be adequate to proving his presence at that time. The jade axes found in the region are described by Professor Kloos; the bronzes by Instructor Voges; the medieval vessels by Dr. Hänselmann; ancient skulls by Dr. Berkhan; local peasant costumes by Dr. Richard Andree; wood carving by Mr. Vasel; megalethic monuments by Inspector Grabowsky; and some curious folk-lore by Pastor Schattenberg. The illustrations are abundant and good.

This is an excellent idea, and ought to be followed in other localities on such occasions.

THE QUERANDIES.

AN extended monograph on Argentine ethnography has recently appeared from the pen of Felix F. Outes ('Los Querandies;' Buenos Aires, 1897, pp. 202; illustrated). It is a study of the culture and affiliations of the tribe which, at the discovery, occupied the site and vicinity of the modern city of Buenos Aires. They were known to early writers as the Querandis, a Guarani term of no ethnic significance. Some authorities have claimed them as of the Guarani stock, others as of Pampean (Aucanian) origin. Mr. Outes, following Lafone Quevedo, holds them to have been of Guaycuru affinity. Only a few proper names remain, and their relics, which he studies at length, are not decisive. The evidence, however, leans in his favor. The same can not be said when he includes their neighbors to the north, the Charuas, in this family also. There is negative evidence which would place those either as a separate stock or among the Brazilian families.

D. G. BRINTON.
UNIVERSITY OF PENNSYLVANIA.

SCIENTIFIC NOTES AND NEWS.

AT the recent meeting of the British Association Professor W. Ramsay and Dr. Morris Travers announced the discovery of a new elementary constituent of air, which they named xenon, the stranger. It has been separated from both air and argon by the process of liquefaction and subsequent distillation. It has a well-marked spectrum, similar in general character to that of argon, and, like it, greatly altered in appearance by the interposition of a jar and spark-gap; but the positions of the lines of the spectrum differ totally from those of argon lines.

THROUGH the generosity of Mr. Cornelius Vanderbilt, the New York Botanical Garden is about to undertake a botanical exploration of the island of Porto Rico. The expedition, which is now being organized, will leave for the new colony within a few weeks, and will carry on collecting of museum and herbarium specimens and living plants for at least six months. Inasmuch as very little is yet known concerning the natural flora of the island, it is confidently expected that much of value and interest will be secured, and the collections will furnish the basis of a report on the botany and vegetable productions of our newly-acquired territory.

DURING the past summer much progress has been made in the New York Botanical Garden, in Bronx Park. The construction of the Museum building has proceeded rapidly, three-fourths of its steel frame being in place, the walls being completed as far as the second story. The warm and wet summer has been favorable to the plants. Much progress has been made in planting the border, which will be completed during the autumn. It will be about two miles in length and will contain some three hundred and fifty varieties of trees and shrubs.

A STATUE of Van Beneden, the eminent zoologist, has recently been unveiled at Malines.

DR. ARTHUR BORNTRÄGER has been appointed Director of the Agricultural Station at Palermo.

MR. W. H. HOLMES, of the United States National Museum, has gone to California to visit the Caliveras region.

Dr. Eugenio Bettoni, Director of the Fisheries Station at Brescia, died on August 5th at the age of fifty-three years.

The sessions of the New York Academy of Sciences will this year be held in the rooms of the American Society of Mechanical Engineers, 12 West Thirty-first Street. It should be remembered by those interested that the Academy meets on Monday evenings at eight o'clock, the first Monday in the month being given to the Section of Astronomy and Physics, the second Monday to the Section of Biology, the third Monday to the Section of Geology and Mineralogy, and the fourth Monday to the Section of Anthropology, Psychology and Philology. The annual meeting and presidential address will be on February 27th.

The other societies forming the Scientific Alliance of New York, which is so greatly in need of a building of its own, will hold their meetings at the following places: The Torrey Botanical Club, at the College of Pharmacy, 115 West 68th Street; The New York Microscopical Society, at the Motte Memorial Library, 64 Madison Avenue; The New York Section of the American Chemical Society, at the College of the City of New York; The New York Minerlogical Club, at the rooms of the American Society of Mechanical Engineers; The American Mathematical Society, at Columbia University; The Linnæan Society of New York and the New York Entomological Society, at the American Museum of Natural History.

A new building has been erected for the Maryland Geological Survey in the rear of the one occupied at present by the Survey and the Weather Bureau, on Howard Street, Baltimore. It is of brick, two stories high, 20 feet wide by 50 feet long. It will be used for experiments and for depositing large pieces of machinery.

The government of New Zealand offers a prize of $10,000 for improvements in the process of treating the native fibre (*Phormium tenax*), known as New Zealand flax. The successful competitor will not be required to surrender title to his invention, or to permit a free use of it in the country which offers the reward.

Consul-General Lincoln, writing from Antwerp, notes that 78,220 pounds of African ivory and 55 pounds of hippopotamus tusks were offered at the quarterly sale of August 2d, the stock on hand being about 174,628 pounds. One can but wonder how long the elephant will continue to exist.

The American Public Health Association held its Twenty-sixth annual meeting at the Parliament Building, Ottawa, Canada, on September 28th, 29th and 30th, under the presidency of Dr. C. A. Lindsay, of New Haven, Conn. The Executive Committee selected the following subjects for consideration: Pollution of Water Supplies; Disposal of Garbage and Refuse; Animal Diseases and Animal Food; Demography and Statistics in their Sanitary Relation; Car Sanitation; Steamship and Steamboat Sanitation; The Etiology of Yellow Fever; The Relation of Forestry to Public Health; The Cause and Prevention of Infectious Diseases; Public Health Legislation; The Cause and Prevention of Infant Mortality; Transportation of Diseased Tissues by Mail; The Period during which each Contagious Disease is Transmissible and the Length of Time for which each Patient is Dangerous to the Community; Sanitation, with special reference to Drainage, Plumbing and Ventilation of Public and Private Buildings; International Arrangement for Protection against the Transmission of Infectious Diseases; Disinfectants; To Examine into the Existing Sanitary Municipal Organizations of the Countries belonging to the Association, with a view to Report upon those most Successful in Practical Results; The Duties and Responsibilities of the Healthy Man for his own and others' Health.

A conference of representatives of the leading underwriting organizations was held in New York for the purpose of adopting a national code of rules governing the use of acetylene gas. It was generally agreed that the use of liquefied gas under pressure should be prohibited. There was a difference of opinion as to whether apparatus for the generation of acetylene should be allowed in insured buildings or whether separate buildings should be required.

A remarkable discovery, as we learn from *Literature*, has recently been made in Dumbar-

tonshire, on the shores of the River Clyde, viz., an undoubted crannog, or dwelling on piles. It is about a mile east of Dumbarton Castle, is below high-water mark, and about 50 yards from the river at low tide. The circumference of the crannog is 184 feet. The outer circle is composed of piles of oak, sharpened by stone axes at the lower end, and below the mud still quite fresh. The transverse beams and pavements are of wood—willow, elder and oak, the smaller branches of fir, birch and hazel, with bracken, moss and chips. The refuse-mound extends about twelve feet outside, and in this have been found the bones of stags, cows, sheep, etc., together with evidences of fire, also numerous firestones and a hone or whetstone. Near the causeway a canoe, 37 feet long and 48-inch beam, was found, hollowed out of a single oak tree. The credit of the discovery is due to Mr. W. A. Donnelly, a keen local antiquary. It is a unique discovery (1) because it is the first example of a crannog situated on tidal waters, and (2) because only flint and bone implements have yet been discovered, and this dates it back into the Neolithic Age. All crannogs yet discovered have contained implements of bronze and other metals characteristic of the Bronze Age, so that this latest find seems at present to be the oldest crannog known.

PROFESSOR ROBERT H. THURSTON, of Cornell University, announces that Mr. P. T. Dodge, of New York, has presented to the museum of the Sibley College of Engineering what is probably, for its size, the costliest piece of machinery ever constructed. This is the Paige type-setting machine, the one in which Mark Twain sunk a lot of money. It consists of 19,000 pieces, controlled by a keyboard, and handles ordinary type, setting, justifying and distributing the matter, and leading it also, when required. It is believed to be one of the most beautifully ingenious pieces of mechanism as well as the costliest. The trouble with it commercially is that it is too ingenious, and, although perfect in the operation, cannot be built for sale. Of course, most of the two millions of dollars this, the original machine, is estimated to have cost, was used in the incessant changing and remaking in which years were spent. The machine occupies a floor space of $11\frac{1}{2} \times 3\frac{1}{2}$ feet, and its highest point is $6\frac{1}{2}$ feet from the floor. The weight is a little less than 5,500 pounds, and it runs without a perceptible vibration.

IN a recent number of the *Berliner klinische Wochenschrift*, as quoted in the *British Medical Journal*, Professor Straussman gives an account of a visit to the Medico-Legal Institute of Bucharest. He says that the medical profession is treated with much greater respect there, and is given a higher and more independent position in the State than in any of our European cities. Professor Minovici, who is the Director of the Institute, is also Coroner and Director of the Morgue, where the bodies lie until identified; if not identified they are buried by order of the Director. The Institute itself is fitted up in the most elaborate manner; every detail has been carefully considered. A large lecture theatre is now being erected near the Institute for teaching purposes. The *post-mortem* room is large and well ventilated, and on the walls are hung diagrams of various parts of the body, which can be referred to when necessary. Bertillon's system of anthropometrical measurement is carried out. A bacteriological and chemical laboratory also forms part of the scheme.

A CORRESPONDENT of the London *Times* writes: A short time ago the London County Council addressed a communication to each of the vestries and district boards throughout the metropolis, asking them whether they would be in favor of the Council applying for Parliamentary powers to establish a bacteriological laboratory. The idea is to appoint an expert or experts in connection with the projected institution, or otherwise to make arrangements whereby medical officers of health and medical practitioners in London could obtain, at the expense of the county, the examination by a competent bactoriologist of material from suspected cases of infectious disease, with a view to aiding in the diagnosis. Owing to the summer vacation of the various local authorities the proposition has not yet been fully considered by the majority, but so far as those are concerned who have paid attention to the question the scheme has met with unanimous approval. Among those authorities who have

already pronounced in favor of the project may be mentioned the vestries of Shoreditch and St. Pancras. In the case of Shoreditch the health committee of the vestry point to the laboratory established by the city of New York some five years ago in connection with a scheme for general bacteriological examination of cases of diphtheria, and state that it has been received by the medical profession of that city with almost unanimous approval. The Shoreditch committee mention further that several towns in the provinces and some of the London sanitary authorities appear to have also made arrangements whereby medical practitioners can send pathological material to experts for bacteriological examination. Believing that it would be desirable in order to secure uniformity and economy that such provision should be made, the Shoreditch Vestry has just informed the County Council of its advocacy of such a laboratory. In St. Pancras the vestry has already made some progress in the direction indicated, since from a report just submitted to the health committee by Mr. John F. J. Sykes, medical officer of health, it appears the vestry early last year sanctioned the examination of pathological material in doubtful cases of diphtheria and typhoid fever, examinations being made when necessary. They are considered essential to the proper notification and prevention of the spread of the disease to which they apply. Two questions have to be considered: (1) whether it is more desirable to carry on the work locally or to centralize it; and (2) if centralized, which is the best method or public body for centralization. In this connection the health committee of the St. Pancras Vestry states that systems have been organized by the several sanitary authorities in conjunction either with the British Institute of Preventive Medicine, the Clinical Research Association or the bacteriologists of the large London hospitals. At the same time the small hospital laboratory at each of the large infectious diseases hospitals of the Metropolitan Asylum Board is utilized for the purpose of examinations of this nature. Taking all the points into consideration, the St. Pancras Vestry have come to the conclusion that a central bacteriological laboratory should be established, and express the opinion that such an institution could be provided by the Metropolitan Asylums Board, under the latter's Parliamentary powers, in the new premises now being built on the Victoria embankment. A letter to this effect has this week been addressed to the County Council. As the London County Council does not meet until next month, and as the Vestries and District Boards are only now beginning to resume their proceedings, some little time will elapse before all the replies are in the possession of the Council. As these will not require much consideration it is possible that the Public Health Committee may be in a position to submit to the Council a recommendation on the subject early in November next.

UNIVERSITY AND EDUCATIONAL NEWS.

A VACANCY has occurred in the office of 'Assistant in Physiology' in the Harvard Medical School. The duties are to superintend the practical laboratory work of medical students, and to engage in original research. The salary is $400. Applications with statement of qualifications should be made at once to Dr. H. P. Bowditch, 688 Boylston St., Boston, Mass.

THE University of Cincinnati has been presented with $60,000 by Mr. Briggs S. Cunningham, a resident of Cincinnati and a member of the Board of Directors of the University. This money will be devoted to the erection of a building to be occupied by the departments of biology and of physics. Plans are being matured and it is hoped that the construction of the building, to be known as Cunningham Hall, will be begun within a month.

ACCORDING to the 'Cambridge University Calendar' for the year 1898-99, the total number of members of the University was last year 13,260, of whom 3,019 were undergraduates. This is an increase of 90 undergraduates over the preceding year. The most important changes in the scientific departments of the University have been the election of Mr. A. A. Kanthack to succeed the late Professor Roy in the chair of pathology; the appointment of Mr. George Griffiths as reader in surgery; the conversion of the University's lectureship of geology into a readership, and the establishment of a lectureship in chemical physiology not yet

filled. Among the minor University appointments during the past year were the following: Mr. Shaw, Emmanuel, Assistant Director of the Cavendish Laboratory; Mr. H. W. Pearson, Christ's, Assistant Curator of the Herbarium. To University lectureships—Mathematics, Mr. Love, St. John's; Midwifery, Mr. Stabb, Downing. The following have been appointed demonstrators: Mechanism and Applied Mechanics, Mr. Peace, Emmanuel; Animal Morphology, Mr. J. G. Kerr, Christ's; Botany, Mr. R. H. Biffin, Gonville and Caius; Pathology, Mr. T. Strangeways Pigg; teacher in Anthropology, Mr. Duckworth, Jesus.

THE chair in the medical department of the University of Pennsylvania, vacant by the death of Dr. William Pepper, will not be filled at present, it being recommended by the faculty that, for the present, Dr. James Tyson, professor of clinical medicine, be given full and general direction of the department of medicine, and that four assistants, Dr. John H. Musser, assistant professor of clinical medicine, Dr. Alfred Stengel, Dr. M. Howard Fussell and Dr. Frederick A. Packard, instructors in clinical medicine, be appointed to deliver, under Dr. Tyson's supervision, didactic lectures on medicine.

MISS AGNES M. CLAYPOLE, PH.B., Buchtel College and M. S., Cornell University, has been appointed assistant in microscopy, histology and embryology at Cornell University.

SECRETARY LONG has directed that the course in naval architecture begun at the Naval Academy at Annapolis last year under the now famous Constructor Hobson be transferred to the Massachusetts Institute of Technology. The course will cover a period of three years, including practical instruction in the summer in ship yards and navy-yards. Eight cadets will be detailed to take the course.

MR. FRANK IRVING SHEPHERD, recently acting professor of chemistry and physics in the University of Denver, has been appointed instructor in chemistry in the University of Cincinnati; and Dr. Thomas Evans, formerly instructor in organic chemistry at the Massachusetts Institute of Technology, and more recently chief chemist of the Proctor & Gamble Soap Company and of the American Cotton Oil Company, has been appointed instructor in technical chemistry at the University of Cincinnati.

PROFESSOR HOFER, of the University at Munich, has been appointed professor of geography in the University at Würzburg. Dr. Loewenherz has been qualified as docent in physics in the University at Königsberg.

DISCUSSION AND CORRESPONDENCE.

THE WINDMILL ILLUSION.

IN the issue of SCIENCE for September 16th Dr. F. C. Kenyon calls attention to the optical illusion to be seen when viewing a rotating electric fan, and requests some explanation of the same. The illusion consists in the apparently capacious reversal of the direction of rotation, and in a corresponding change of the plane of rotation.

This phenomenon has long been known to those who have investigated illusions of motion. So far as the writer's knowledge goes, it was first mentioned in literature in 1860, by the German Sinsteden. * Since that time frequent mention has been made of it and several explanations have been propounded. The essentials of the illusion can be seen in the case of windmills, electric fans, rotating bars, or rotating disks bearing heavy radial strips of black. For all of these the name of 'The Windmill Illusion' is currently employed.

The explanation of the illusion is obviously to be sought in the interpretation of equivocal factors entering into the total experience known as the perception of rotation. Sinsteden, and Helmholtz after him, tried to explain the matter along this line. That *eye-movements* do not enter in has been shown by experiments reported by Dr. Nichols at the first meeting of the American Psychological Association. The essence of the explanation lies in the consideration that the perception of rotation often rests upon the perception of distinct positions of the rotating body, and that the succession of these various positions or phases of rotation admits of either of two interpretations as regards the direction of rotation. That we do perceive motion by means of its phases may be readily demonstrated by rotating a disk bearing variously colored sectors in a dark

* Poggendorff's Annalen, CXI., 336.

room, the illumination being furnished by the electric spark. The rotation of the disk will seem to be now in one direction, now in the other, according as any sector, made visible by the instantaneous flash, is seen to occupy a position on this or that side of the sector seen just previously. If in addition any perceived phase could admit of a double interpretation we should have the illusion in question.

The reason for the illusion may, perhaps, be seen in this way. Fancy, for example, a narrow pennant floating from a staff, the observer being so placed that the line of direction of the pennant shall make an angle of, say, 30° with the plane passing through the observer and the staff. Further, let the pennant droop somewhat from the horizontal. If, now, this be viewed from a sufficient distance and by a somewhat dim light, it will prove impossible to determine absolutely whether the pennant is floating towards or away from the observer. That is, we have here a simple case of equivocal interpretation. The same double interpretation is true for every pair of positions between those just considered and the point where the pennant is perpendicular to the plane above mentioned. Suppose now that the pennant be made to rotate about the staff, occupying successively each of these positions. Manifestly the direction of rotation can not now be determined with full satisfaction, for since each of the phases seen was capable of a double interpretation, their succession must give rise to a possible perception of rotation in either of two directions, either from a position more remote to one nearer, or *vice versa*. Probably one direction will always be selected as *real* over against the other as illusory, for there are usually some subordinate factors that are dimly perceived which admit of only a single meaning.

Here then we have a type of the illusion. Now let the pennant be replaced by the vanes of a windmill or by the blades of an electric fan, and we find further equivocal factors present. Take the latter case. Not only the direction of the rotation, but the *slope of the blades* as well may be perceived in two ways. For the patches of light and shade, on the basis of which the slope is perceived, are also equivocal, and the particular illusory perception that we get, not only of the *direction*, but also of the *plane* of the rotation, depends upon the special combination of these two equivocal factors. The whole matter is then at bottom one of the perspective interpretation of successive perceptions of light and color in their various combinations.

The above explanation is strongly substantiated by the universally observed fact that the rotating object must be viewed at a certain distance or by a dim light. That is, certain details which admit of but one meaning must be suppressed before the illusion can arise. Again, the fact that the illusion is at its best when the rotating object is viewed very *obliquely* makes for the explanation given. For here perspective interpretation is given full play. This oblique position of the observer is, however, not necessary in every case, for the writer has repeatedly seen the illusion when viewing a four-vaned windmill directly *en face*. Further, this explanation is strengthened by the fact that the illusion is most clear when one eye is covered.

Which one of the rotations shall in any given case be seen, when either is equally possible, will depend probably upon the position of the eyes. This is influential in all equivocal perceptions, and, as Wundt has pointed out, the law seems to be that the point fixated appears nearest to the observer.

Attention may be called here to a somewhat similar illusion mentioned by Silvanus P. Thompson in the *Quarterly Journal of Science* for 1879. If a crow be seen at dusk flying low against the sky the wings, seen alternately above and below, give the appearance of a single wing rotating about the crow's body like the blade of a screw propeller about its axis. The points of similarity between this and the Windmill Illusion are manifest.

A. H. Pierce.

Amherst College.

Mr. Kenyon's optical illusion described in your issue of September 16th may be best explained by another illusion with which I have been long familiar.

Take an ordinary glass goblet, tilt it a little from you, so that the farther rim is seen

through the glass. Shut one eye so as to get rid of binocular perspective.

You can now at will change the relative position of the two parts of the rim. At one moment you see the farther rim through the glass in its true position; at another it seems the nearer of the two and you seem to be looking into the mouth of the goblet.

Now, if the glass were rotating, it is evident that it would seem to rotate in the one direction or the other, according as we imagined the real or the reversed position of the rims.

The phenomena can be seen with both eyes open, but is clearer with one eye shut for the reason already given.

Now, I think the phenomenon of the rotating fan is explained in a similar way. The observer, I suppose, looked at the fan from a little *below* the horizontal, but seemed to be looking at it from *above*, when the rotation was apparently reversed.

JOSEPH LECONTE.

BERKELEY, CAL., September 24, 1898.

[A similar explanation has been sent us by Mr. Garrett P. Serviss, Jr. It is the explanation of Sinsteden, who first described the phenomenon in 1860, as stated above by Mr. Pierce. *Cf.* von Helmholtz, *Physiol. Optik.*, 1895, p. 770.—ED. SCIENCE.]

SCIENTIFIC LITERATURE.

Memoirs from the Biological Laboratory of the Johns Hopkins University, IV., 1. *The Cubomedusæ.* A Dissertation presented for the Degree of Doctor of Philosophy, in the Johns Hopkins University, 1897. By FRANKLIN STORY CONANT. A Memorial Volume. Baltimore. 1898.

The late Dr. Conant, it will be recalled by many, was a member of the marine laboratory of the Johns Hopkins University, stationed during the summer of 1897 at Port Antonio, Jamaica. Toward the end of the season's work fever broke out. The director of the expedition, Dr. J. E. Humphrey, died in a sudden and alarming manner. Dr. Conant assumed charge of the laboratory, and, though aware of his own great danger, remained in Port Antonio, devoting himself to the service of others who needed his help. This generous subordination of self cost him his life, for he contracted the fever, and, though able to reach this country, he died a few days after his arrival in Boston.

Dr. Conant's many friends, well aware of his candid, judicial mind, his keenness and persistency in observing and in reasoning from observations to a conclusion, have entertained the highest expectations of the work he was to do in science. Cut off at the beginning of his career, he leaves behind him several smaller papers and the dissertation before us. On closing this volume the author's friends will feel confirmed in their high opinion of his abilities, and those who did not know Dr. Conant will realize with regret that an able and conscientious naturalist has been removed from our midst.

Dr. Conant's dissertation, published as a memorial volume by his friends, fellow students and instructors, with the aid of the university in which he had recently taken his doctor's degree, deals with the anatomy and classification of one of the most interesting groups of jellyfish, the Cubomedusæ. In this group, embracing but a small number of species, the scyphomedusan structure, with which most of us are chiefly familiar through the study of *Aurelia*, *Cyanea* or *Dactylometra*, is in general presented as destitute of the complications which characterize the more common forms. This simplicity in general structure places the group close to the stem-forms, *Tessera* and *Lucernaria*, themselves scarcely more than sexually ripe *Scyphistomas*, and makes a comparison with existing Actinozoa an easy matter. Curiously enough, the members of this primitive group possess the most highly developed sense-organs as yet described among coelenterates, the nervous system being correspondingly differentiated. In one other respect the Cubomedusæ are unique, in that they alone among the Scyphomedusæ possess a velum. The phylogenetic origin of this velum (velarium) has been the subject of some discussion, the balance of opinion inclining to the belief that it has arisen through the fusion of marginal lobes similar to those found in the Peromedusæ and the Ephyropsidæ (*Nausithoë*), and is merely analogous to, not homologous with, the velum of the Hydromedusæ. That this is the case is borne out by the presence in the velum of gastrovascular diverticula. This

resemblance to the Hydromedusæ is regarded by most naturalists as one of the numerous cases of convergent evolution exhibited by the two groups of jelly-fish (Hydro- and Scyphomedusæ), due to similarity in environment and to a certain similarity in the ancestral polyps from which the two groups have been derived.

The Cubomedusæ are so rare that in spite of their interesting features, interesting alike to the student of phylogeny and nerve-physiology, few naturalists have had the opportunity of studying them. Our knowledge of the group has rested mainly on Claus's description of *Charybdea marsupialis* (Wien. Arb. 1878). This very valuable paper, as Conant remarks, is written in a style difficult of comprehension, and many students who read with pleasure and profit the lucid treatises on medusan structure by the Hertwigs and Haeckel have turned away discouraged from Claus's work. To Claus's account, Haeckel in his 'System' has added but little. The only other investigator the group of is Schewiakoff (1889), who has studied the remarkable sense organs.

Through Conant's discovery in 1896 of two new species (*Charybdea Xaymacana* and *Tripedalia cystophora*), which are present in abundance in Jamaican waters, the Marine Laboratory of the Johns Hopkins University has once again made accessible to students, material for the pursuit of investigations of wide interest. It was for the purpose of continuing his study of this group that Conant, in the summer of 1897, revisited Jamaica, and, as we learn from Professor Brooks's introduction, he succeeded in making many observations on the physiology of the sense-organs and on the embryology. His notes and material, we are told, are in such shape that they can be handed over to some one else, and it may be safely predicted that a valuable contribution to science will be the outcome of the last summer's work of this talented young naturalist.

The account of the subomedusa structure given by Dr. Conant is succinct, but comprehensive. The deep, four-sided bell bears a tentacle (or in some species a bunch of tentacles) at each angle. On each lateral surface, at a higher level than the tentacles, is situated a niche into which projects a sense-organ. The primitively undivided (Scyphistoma condition) gastrovascular space is here differentiated into a central stomach and a peripheral portion lying in the lateral wall of the bell. The peripheral portion is subdivided into four stomach pockets by linear partitions, lying in the plane of the tentacles and therefore interradial. These partitions (cathammæ) are mere strips of entodermal lamella, produced by the fusion between the entodermal linings of ex- and subumbrella. The cathammal lines stop short of the tentacles, leaving an undivided peripheral portion of the primitive space, by means of which the four stomach pockets communicate with one another. As Conant points out, the arrangement recalls the gastrovascular system of many Hydromedusæ, with the difference that in the Cubomedusæ the radial canals are wide 'stomach pockets' and the cathammal plates are narrow lines. When we come, however, to the extreme peripheral portion of the gastrovascular system, we find that the likeness is not with the Hydromedusæ, but with the lobed Scyphomedusæ. The gastrovascular space, to be brief, does not end with an even circular edge at the bell margin, as is the rule in the former group, but is divided into separate lobes (marginal pockets) extending into the velum (as velar canals). Conant does not dwell on phylogenetic inferences, but evidently inclines to the belief that the ancestors of the Cubomedusæ possessed a margin divided into sixteen lobes. The present position of the four sense organs indicates the site of the original margin, "which elsewhere has grown down and away from its former level, leaving the sensory clubs like floatage stranded at high-water mark." Fusion between adjacent lobes, involving the ectoderm and jelly, gave to the medusa a continuous margin and a 'velum,' but, owing to the incompleteness in the fusion of the *entodermal linings* of the several lobes, the latter still retain in the adult Cubomedusa enough of their individuality to indicate their former condition. In a word, the marginal pockets of the existing Cubomedusa are to be construed as entodermal linings of once separate lobes.

This conclusion as to the morphology of the marginal pockets derives much support from the behavior of a puzzling structure, called by

Conant the marginal lamella. Unlike the true vascular lamella, which simply connects one entodermal cavity with another, the marginal lamella extends from the entoderm of the gastrovascular space to the ectoderm of the bell margin. It is a narrow strip which follows the outline of the marginal pockets, traveling in the radii of the sense organs far away from the actual edge of the bell, and surrounding the sense organs in such a way as to indicate clearly that they were once at the bell margin. The marginal lamella seems to be a functionless, rudimentary organ. Claus, whose imperfect description of the structure did not bring to light its morphological interest, as indicating the site of the ancestral bell margin, suggested that it was perhaps the vestige of a ring canal. Conant naturally is skeptical of this explanation of a lamella connecting ento- and ectoderm. The true meaning of this peculiar lamella is a point well worth working up, more especially as it is not confined to the Cubomedusae, but has been observed in the ephyra lobes of discophores (*Rhizostoma*).

Before leaving this subject of the general body-plan, it may be mentioned that while the probability is that the Cubomedusæ are descended from stalked ancestors (*Luceruaria*-like forms), and hence that the apex of the exumbrella was once drawn out into a peduncle, there is in the adult Cubomedusa no trace externally nor internally of this hypothetical stalked condition. Light on this very interesting point can only be expected from a study of the development.

Unlike the other Scyphomedusæ studied, the Cubomedusæ possess a nerve ring. In their study of the nervous system Claus and Conant both depended on sections, and naturally the results are not so satisfactory as those reached by the Hertwigs on the Hydromedusæ mainly with the aid of macerations. Claus describes the neuro-epithelium as consisting of alternating supporting cells and sensory cells, the inner ends of the latter becoming continuous with the nerve fibres. Conant makes it doubtful whether this is the actual condition, since he does not find the sensory cells. He offers, however, no observations on the origin of the 'nerve fibres.' Macerations will probably show the connection of these fibres with at least some of the neuro-epithelium cells.

The possession of a nerve ring has been regarded (Claus) as a point of essential similarity between the Cubomedusæ and the Craspedota. The main ring in the former group is obviously a differentiation of the subumbrellar epithelium, and Claus, therefore, interprets it as homologous with the inner Craspedote ring. In the immediate neighborhood of each sense organ there are given off from the main ring two roots which *ceasing to be superficial bands* pass through the jelly, and emerge on the outer wall of the bell (on the floor of the sensory niche). They converge and unite, forming a superficial nerve tract which crosses the base of the sense-club. These four isolated tracts are regarded by Claus as the remnants of a once continuous exumbrellar ring, such as is found in the Hydromedusæ, and which here, as in the Hydromedusæ, stands in connection with the subumbrellar ring though the medium of fibres that perforate the jelly. Conant, on the other hand, regards the tracts lying across the bases of the sense organs as portions of the primitive subumbrellar ring which were shut off from the main ring, when the marginal lobes grew together. With the Hertwigs and Haeckel he thus looks on the ring as not homologous with that of the Craspedota, but as a special differentiation of the subumbrellar plexus found throughout the Scyphomedusæ.

The sense organs of the Cubomedusæ are 'sense-clubs,' or modified tentacles. In addition to the crystalline sac, the expanded head of the club bears six eyes. Four of these are simple, but two are complex organs provided with a cellular lens and cornea, a vitreous body behind the lens, and a retina. These eyes look into the bell cavity. It is especially in reference to the structure of the retina and vitreous body of the complex eyes, that Conant's conclusions differ from those of Schewiakoff. The vitreous body Conant finds is not a homogeneous structure, but is composed of prisms of refracting substance. The retina does not show the two types of cells (sensory and pigmented) distinguished by Schewiakoff. Conant's results in this matter of the retinal structure are in some respects negative. The points still to be

cleared up are as in the case of the nerve cord, such as will require the free use of macerations and surface preparations of fresh tissue.

H. V. Wilson.

SCIENTIFIC JOURNALS.

The American Journal of Science for October opens with an important article by Professor C. Barus, describing experiments on the impressibility of celloids. The author points out that as with gelatine the same body may manifest itself both as a liquid and a solid, so the same ether may act, as the case may be, either as a liquid or as a solid. Professor C. E. Beecher concludes his series of articles on the origin and significance of spines. He has shown that spinose forms were all derived from non-spinose ancestors, and were simple and inornate during their young stages. Spines represent an extreme of superficial differentiation and out of spinose types no new types are developed. Director Chas D. Walcott writes on the brachiopod fauna of the quartzitic pebbles of the Carboniferous conglomerates of the Narragansett Basin and Rhode Island. The number also includes articles on the eolian origin of loess, by C. R. Keyes; on dikes of felsophyre and basalt in Paleozoic rocks in central Appalachian Virginia, by N. H. Darton and A. Keith; on diaphorite from Montana and Mexico, by L. J. Spencer; on the detection of sulphides, sulphates, sulphites and thiosulphates in the presence of each other, by P. E. Browning and E. Howe, and on twinned crystals of zircon from North Carolina, by W. E. Hidden and J. H. Pratt.

The *American Naturalist* for September publishes the Vice-Presidential addresses at Boston of Professors Packard and Farlow and contains in addition an article by Mr. E. O. Hovey, describing the museums he visited last year when in Europe attending the International Geological Congress. Special attention is paid to geology, mineralogy and paleontology.

Professor H. Poincaré, of the University of Paris, contributes to the October *Monist* an article 'On the Foundations of Geometry,' in which he considers the questions of the origin of space and the feeling of direction, of the classification of displacements, of the properties of groups and sub-groups, of continuity and discontinuity, of the notion of point and number of dimensions, etc. In the same number Professor Ernst Schroeder, of Karlsruhe, has an article 'On Pasigraphy,' in which he sums up the history of the movement, and briefly characterizes the present state of research in this department. Dr. Topinard concludes his series, 'Science and Faith,' with an article on 'The Social Problem,' in which he outlines a plan for the rehabilitation of society by systematic interference with the workings of so-called 'natural' evolution.

The *Educational Review* for October contains the following articles: 'The Public Education Association of New York,' by Mrs. S. Van Rensselaer; 'Study of Education at the German Universities,' by Walter L. Hervey; 'Herbartian Philosophy and Educational Theory,' by Arnold Thompkins; 'Why College Graduates are Deficient in English,' by Annie E. P. Searing; 'The New Jersey System of Public Instruction,' by James M. Green, and 'What Modern Philosophy Offers Secondary Education,' by O. L. Manchester and H. H. Manchester.

NEW BOOKS.

Thermodynamics of the Steam-engine and other Heat-engines. Cecil H. Peabody. New York, John Wiley & Sons; London, Chapman & Hall, Ltd. 1898. 4th Edition. Rewritten and Reset. Pp. iv + 522. $5.00.

The Discharge of Electricity through Gases. J. J. Thomson. New York, Charles Scribner's Sons. 1898. Pp. x + 203. $1.00.

Theories of the Will in the History of Philosophy. Archibald Alexander. New York, Charles Scribner's Sons. 1898. Pp. viii + 357. $1.50.

Four-footed Americans and Their Kin. Mabel Osgood Wright. Edited by Frank M. Chapman. New York and London, The Macmillan Company. 1898. Pp. xii + 432.

Differential and Integral Calculus. P. A. Lambert. New York and London, The Macmillan Company. 1898. Pp. x + 245. $1.50.

An Introductory Logic. James Edward Creighton. New York and London, The Macmillan Company. 1898. Pp. xiv + 392. $1.10.